

**PHONOLOGICAL AWARENESS SKILLS IN KINDERGARTEN CHILDREN WITH
AND WITHOUT PHONOLOGICAL IMPAIRMENT**

By
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Abstract of Dissertation Presented to the Graduate School
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**PHONOLOGICAL AWARENESS ABILITY
IN KINDERGARTEN CHILDREN WITH AND WITHOUT PHONOLOGICAL
DISORDER**

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Phonological awareness is the ability to manipulate individual speech sounds without regard to meaning. It is recognized as a key component of reading acquisition. Children with phonological impairments are believed to be at greater risk for phonological awareness deficits. If children have not fully acquired the speech sounds and sound systems of English, they may not be able to identify and manipulate sounds/syllables needed in later to-read. Thus, understanding the nature of phonological awareness skills in children with phonological disorders is useful for identifying children who may be at risk of reading failure.

The purpose of this study was to compare phonological awareness abilities in kindergarten children with diagnosed articulation or phonological disorders to the abilities of typically-developing kindergartners. Subjects included 40 children with

and 10 children without phonological disorders (matched on age, nonverbal ability, receptive vocabulary, expressive vocabulary, and classroom teacher). Ages ranged from 3;0 to 4;0. Children attended kindergarten in Palm Beach County, Florida.

Subjects were administered a measure of nonverbal ability, a test of receptive vocabulary, and a test of expressive morphology. Phonology was evaluated using a standardized test of productive phonology (*Star-Burst Articulation and Phonology Evaluation*), a monosyllabic word naming task, and a battery of 30 phonological awareness tasks. Phonological awareness tasks were designed to test skills at all levels of phonological analysis: syllables, morphemes (onset rimes), and phonemes.

Total phonological awareness scores were calculated and compared for the two groups, and significant group differences were found. *Bliss* production-substitution scores were also significantly different. Children with phonological impairment scored lower on the phonological awareness tasks than their typically developing peers. Phonological error patterns that correlated with phonological awareness scores were percent consonants correct of the items in the monosyllabic word naming task and the use of the phonological process metathesis. Both groups found blending tasks to be the easiest and a final consonant deletion task to be the most difficult. Results indicated that some phoneme-level tasks (blending) were easier than onset-rime-level tasks, but smaller phoneme-level tasks (final consonant segmentation) were more difficult than onset-rime and syllable-level tasks.

CHAPTER 1 INTRODUCTION AND REVIEW OF THE LITERATURE

Introduction

Over the past two decades, researchers have established that deficits in phonological awareness are closely related to deficits in early reading ability (Bird & Buchanan, 1974; Bishop & Byrne, 1993; Byrne & Fielding-Baxendale, 1993; Fox & Raskin, 1990; Lundberg, Frey, & Peterson, 1988). In determining which children are most likely to have deficits in phonological awareness (and therefore difficulty with reading acquisition), children with speech and language impairments were identified as especially at risk for reading disability.

At the same time, there are conflicting reports in the literature about the nature of the relationship between speech and language impairments and phonological awareness. Although some of the research links phonological impairment to phonological awareness deficits (Bird, Bishop, & Freeman, 1993; Lonigan, Hughes, & Fletcher, 1997; Watkins & Platts, 1992), there are also reports of children with phonological impairments and no phonological awareness or reading impairments (Catts, 1993; Maguire & Hewson, 1993). Because much of reading disability is attributed to deficits in phonological awareness, research on the relationship between speech and language impairment and phonological awareness has focused on reading outcomes, rather than on a deeper understanding of phonological awareness and its interaction with speech or language impairment.

Phonological awareness is the ability to manipulate sounds independent of meaning meaning. According to Catts and Kavanagh (1992) there is no other variable statistically related to word recognition or reading as phonological awareness. This general skill develops as a hierarchical fashion from simple to complex phonological manipulations (along with other aspects of metalinguistic awareness) during the preschool and early school years, progressing from awareness of larger linguistic units such as the word, to the syllable, then manipulative units of onset and digraph, and finally to phonemic units. Phonemic awareness is the ability to manipulate individual phonemes, and it is this level of phonological awareness that is most consistently linked with reading disability. Children who have deficits in phonemic awareness have difficulty learning to read and spell, and their difficulties may persist despite intervention (Torgesen, Wagner, & Rashotte, 1994). There is sufficient evidence to suggest that early training of phonological awareness skills can prevent reading disability in all but the poorest of readers (Torgesen & Green, 1990; Torgesen et al., 1994). Therefore, it is critical to identify children who are at risk for reading failure as early as possible, and provide them with interventions that will enable them to achieve academically.

Phonological impairment refers to impairment in the organization and production of speech sounds (Ferguson-Wangler, 2004). The term can refer to problems with articulation or speech sound organization reflecting maturational or linguistic deficits that lead to speech sound errors (Shelberg & Kuznetsovskaya, 1983). Children with phonological impairment are a heterogeneous group and may include children with and without language impairment (Shelberg & Kuznetsovskaya, 1983).

Researchers have established that children with language impairments, especially those who have syntactic and morphological deficits, are poorer readers than children without language impairments (Bishop & Adams, 1990; Catts, 1993; Catts & Fey, 1995; Maguire & Mowles, 1986-1995; Scarborough, 1990). Within the group of children with language and reading deficits, children with expressive phonological impairment have been identified as having particular difficulty with reading acquisition. An expressive phonological impairment seems to amplify the effects of the reading deficits of children who have other language impairments. This has led researchers to question whether development of expressive phonology is explicitly tied to development of phonological awareness.

Previous studies of the relationship between expressive phonological impairment and phonological awareness have achieved one common finding, which is that children with severe phonological impairment have lower phonological awareness (Bad et al., 1995; Ingram & Burchard, 1994; Windsor & Plante, 1992). However, there have not been findings that conclusively establish a link between the two sets of skills and identify clearly a group of children with mild, moderate, or severe phonological impairment who are at risk for phonological awareness deficits and reading disability.

The body of research on phonological awareness in young children is vast, but it is difficult to draw specific conclusions about a child's overall phonological awareness development because there is little consistency in both *definition* from study to study. Most studies report on only a few (or even one) types and levels of tasks. In many studies, children perform at ceiling levels on phonological awareness tasks, resulting in little productive information emerging from the research. Additionally, languages

elements that affect task difficulty have been visually ignored. For example, recently, Yavas and Dogan (1999) highlighted the role that nasality plays in segmentation ability for both normal and hearing-impaired. They found that words containing segments such as liquids and nasals were consistently more difficult to segment from the adjacent vowel than less nascent segments (such as stops and fricatives). Other linguistic factors to consider include word position, linguistic function of unit being manipulated and phonetic features of manipulated words.

Because there is very little comparative research on phonological awareness across levels of task difficulty, it has been difficult to establish a hierarchy of abilities. Understanding a child's skill level, and the typical developmental progression of phonological awareness skills, would help researchers determine a child's deficits and help place a child in a remedial program when appropriate.

In almost all of the studies on phonological awareness and segmental phonological ability, some of the subject's best language impairments lie within the phonological requirements. Children with both phonological and language impairments rather than purely phonological disorders were found to have the most difficulty with phonological awareness tasks (Berchowitz, Edwards & Rappaport, 1996; Best et al., 1999). To understand how phonological awareness relates to phonological production ability, a group of children with only phonological impairments (and no other language impairments) needs to be studied. To date, phonology has been measured by administering brief segmental subtests (which have not been linked to measures of reading ability among children with phonological impairments). Production of more complex words such as the mother/father words used in Laxness and Goff's (1999) study, has been

linked to literacy outcomes, but speech production accuracy in different syllable structures is not typically included as articulation and phonology tests. It may be the case that the articulatory level measures, in comparison with other phonological measures, are a better indicator for phonological awareness. A multiple approach phonological analysis including process analysis and phoneme accuracy in single words and multisyllable words may give further insight in the types of deficits in phonology that may cause or affect deficits in phonological awareness.

The purpose of our study was to compare phonological awareness deficits in a group of children with no speech or language impairment to the children of a group of children with expressive phonological impairments and normal expressive and receptive language. A need for this research stems from the fact that children with phonological impairment also are at particular risk for reading difficulty and to be identified as early as possible to receive preventive phonological awareness training in addition to other speech or language intervention. No previous studies have linked expressive phonology from other language deficits to establish the nature of the relationship between phonological production ability and phonological awareness.

Review of the Literature

The next section addresses the following topics: (a) phonological awareness: its description and measurement, (b) the relationships between phonological awareness and spelling acquisition, (c) the relationships between phonological awareness and phonological production, (d) the nature of phonological impairments and measures of impairment, and (e) phonological awareness and phonological speech acquisition.

Phonological Awareness

Phonological awareness describes a broad range of abilities related to understanding and manipulating speech sounds independent of their meaning (Buckwalter, 1997). Typically, phonological awareness refers to a group of metalinguistic skills that involve manipulation of units of speech, such as words, syllables, onset/rhyme units (e.g., onset substitution), and phonemes. Collier and Dahl (1987) described phonological awareness as a child's knowledge of the actual structure of spoken language. Phonological awareness skills develop during the preschool years and progress from larger units, such as the word or syllable, to the smallest unit, the phoneme (Grimm & Zakorwicz, 1994). Thomas (1991) described phonological awareness as awareness of any of the phonological units of language, and described phonemic awareness as the ability to recognize that a word is composed of individual phonemes. Phonemic awareness is the ability to manipulate individual speech sounds of a word, and is the level of phonological awareness most closely linked to literacy acquisition.

Phonological awareness is assessed by a variety of tasks that target different levels of ability. Examples of the tasks that target the word level include segmenting spoken sentences into words by counting the number of words in a sentence, or tapping out the words in a sentence. Judgments of word length have also been reported in the literature (Grimm & Bryant, 1990). At the syllable level, segmentation tasks are often used. These tasks also involve tapping out or counting the number of syllables in a word, or saying a multisyllable word, then deleting a syllable and repeating the remaining word. Onset/rhyme tasks include rhyme judgments, rhyme production, rhyme matching,

word matching, nonsense-syllable matching, phoneme production, and blending onset and rhyme.

The most difficult phonological awareness tasks involve the manipulation of sounds at the phonemic level (Troiman & Zakorski, 1988). Tasks of this nature require children to identify or manipulate individual phonemes and include phoneme segmentation and blending, phoneme counting, phoneme categorization, phoneme deletion and phoneme transposition.

Development of phonological awareness

Lieberman, Shneiderman, Lieberman, Fowler, and Fowler (1987) claimed that development of phonological awareness skills takes place during the early school years, when children are learning to read. Because this skill develops alongside reading acquisition, it was not clear whether phonological awareness develops as a by-product of reading, or whether it is a precursor to reading. However, it is currently accepted that the relationship between phonological awareness and reading is bidirectional. Young children acquire early phonological awareness skills, then progress to decoding and reading acquisition. In studies of adults who could not read, Morais, Cary, Alegria, and Bertolo (1987) found that orthographic literacy leads to segmentation skills, and they argued that phonological awareness develops as a result of reading acquisition. As children gain experience with the alphabetic principle, their ability to segment phonemes improves. Ruddy, Bryant, MacLean, and Bradley (1987) reported a similar finding. Children who had already begun to learn to read did better on a final nonsense categorization task than children who had not begun reading. Data show unequivocally that exposure to the alphabetic principle leads to better awareness at the phonemic level. It seems that

phonological awareness is necessary to begin to learn to read, but as reading skills improve, higher-level phonetic awareness skills also improve.

In general, awareness of larger units, such as the word or syllable, precedes awareness of smaller units, such as onset-rhyme or phonemes (Thomas & Zakariasen, 1990). Chaffey & (1992) have also proposed that acquisition of phonological awareness begins with early language play, such as early rhyming and word play, and progresses to onset-rhyme tasks, then phoneme-level tasks. Results from a recent narrative study by Best, Byrne, and Goswami (1999) corroborated the same general hierarchy of skills, progressing from syllables to the phoneme level.

Pea and Kuczaj (1992) study showed a clear developmental progression in phonological awareness. They found that younger children were less able than older children to perform segmentation tasks. This finding held for three groups of children. 4-year-olds performed better than 3-year-olds, and 3-year-olds performed the best. Bryant, Bradley, MacLean, and Crossland (1989) showed that although 3-year-old children were not successful on a task of rhyme detection, by age 4.7 the group scores were normally distributed. Together, these findings show that children improve in their ability to perform phonological awareness tasks as they get older.

Considerable evidence exists for development of phonological skills during the preschool and early school years before reading instruction begins. Some research has reported children playing word games involving rhymes at 2-4 years of age (Chakrabarty, 1982). However, no reported assessment of phonological awareness has been conducted on children that young. MacLean, Bryant, and Bradley (1991) found that children as young as 3 years old know memory rhymes and could produce and detect rhymes in

phonological awareness tasks. Similarly, Burchett et al. (1990) found that 100% of the 3-year-olds they investigated were able to produce rhymes, and 10% were able to produce alliterations. Some children are able to complete rhyme and alliteration tasks successfully before learning to read (Bradley & Bryant, 1983). Bryant et al. (1983) studied the rhyme detection ability of 3-year-old children and concluded that children aged 3-4 were not able to emotionally detect rhyme. Fox and Routh (1982) established that 3-year-old children could segment sentences with some consistency and were also able to segment some words into syllables. Treiman (1982) found that preliterate children could detect rhyme, produce rhymes, and perform some phoneme replacement and deletion tasks.

As noted earlier, several researchers found syllable-level tasks easier to perform than word rhyme or phoneme level tasks. Liberman, Shankweiler, Fischer, and Carter (1974) asked 3-year-old children to tap out the syllables in a word, and then the phonemes in words. They found that the children were able to tap out the syllables but not the phonemes. Treiman and Smith (1987) confirmed that although 3-year-old children could complete a syllable-level task, they were not able to complete a phoneme level task. Treiman, Torgoff-Foxinger, Simon-Morrisio, and Francis (1994) found syllable-level tasks easier than rhyming tasks for kindergarten children.

Tasks that involve rhyming require knowledge of the morphological level. They require explicitly or implicitly segmenting the word from a word to identify the rhymic. Treiman and Borowsky's (1990) work definitively showed that the linguistic function of a nasal affected phoneme identification ability in preschool and kindergarten-age children. That is, children were able to segment the onset of a syllable rather than the initial phoneme of a word, even though both segments are word-initial phonemes. When

children were asked to say whether they heard a sound in a word, they more readily identified the sound when the sound was the single member sound (as in /p/ in *pat* and *pen*) than when the sound was in word medial positions (i.e. a cluster sound like /p/ in *pin* and *prep*).

By 3 or 4 years old, a child is able to perform tasks at the onset and rhyme level (Culico (1977) found that 3- and 4-year-old children could easily segment onset and rhyme). Berman, Cummings, and Cowan (1984) found that kindergarten children performed at ceiling for tasks involving rhyme identification and rhyme supply.

Several researchers found that children who can perform syllable or onset-rhyme-level tasks could not perform phoneme-level tasks (Berman et al., 1984; Bryant, MacLean, Bradley & Crossland, 1980; Treiman & Bates, 1981). Within the group of phoneme-level tasks, there are varying degrees of task difficulty depending on whether or not a segment is a member of a consonant cluster the word position in which a segment occurs. For example, Treiman and Berman (1981, 1986) found that children had more difficulty matching phonemes that were members of different consonant clusters (e.g. /p/ in *pin* and *prep*) than when the consonants appeared as singletons. Rastle et al. (1994) found that identifying the final sound of a word was difficult for 5-year-olds. Bryant et al. (1989) tested phoneme identification abilities of children aged 5-7 and found that initial phonemes were identified much more successfully than final phonemes.

In general, because such a wide variety of phonological awareness tasks have been used, and ages of children involved are less consistent from task to task, it is difficult to determine whether certain types of phoneme-level tasks are more difficult than others. However, a few studies have shown how task type affects difficulty of tasks

within one level. For example, Bryant et al. (1984a) found that tapping (printing) phonemes was performed at a much more successful rate than consonant deletion tasks. This indicates that although tapping phonemes (writing phonemes) and deleting phonemes are both phoneme-level tasks, tapping is clearly an easier task and is a good example of the way that task type affects performance.

Tanner and Minifie (1981) illustrated difficulties in comparing results from phonological awareness studies. They compared the task demands of a phoneme reversal task (Adams, Pugh, & Minifie, 1982) with three other phoneme representation tasks, which required children to tap out phonemes in words spoken by the examiner, and concluded that the results from the two studies could not be compared easily. The authors pointed out that because more steps are required to complete the phoneme-reversal task (segment, stretch, and then reverse stretch), the two tasks do not measure the same abilities equally. Tanner and Minifie recommended using tasks that do not involve extraneous processes to assess actual phonological awareness abilities. Topp (1981) identified tasks that required multiple steps or high memory load and grouped tasks into simple phoneme awareness and compound phoneme awareness, based on the steps to completion and memory load required to perform the task. Tasks increased difficulty as increasing phonological awareness, and the best measure was a combination of simple and compound tasks.

Linguistic influences such as soundness, phonetic features of words, and word position of sounds have been variably quoted in research that explores phonological awareness skills. However, a handful of researchers have established that the type of phonological segment (e.g., consonant or vowel) influences task difficulty and

that other linguistic factors should be considered when developing phonological awareness tasks. Yavas and Goggin (1995) found that two groups of children had difficulty segmenting monosyllabic words that were more frequent than an adjacent word, regardless of whether the word was word-initial or word-final. Leland and Carter (1981) found that the number of phonemes shared in a rhyming task predicts a task more complex than identifying the odd-man-out in a set of rhyming words in which the odd-rhyming word shares two phonemes with one of the rhyming words is more difficult than when one phoneme is shared, or no phonemes are shared. For example, identifying the odd-man-out in *man, goat, cat, dog* is easier than in *man, goat, cat, egg* which is easier than in *man, goat, cat, egg*. Hall (1981) recommended a progression for teaching phoneme-blending skills that includes word position and segment type. She recommended beginning by blending singletons word to object (e.g., *c, cat*), then blending final phonemes only (e.g., *...at, cat*), then blending three-phoneme words with a consonant sound in initial position (e.g., *cat, cat*) then three-phoneme words with a stop consonant in initial position (e.g., *cat, cat*).

Relationship of phonological awareness to reading and spelling

Phonological awareness has been linked to reading and literacy acquisition in a variety of age levels by a variety of experimental paradigms, and across several languages (Catts & Randa, 1999). By 1980, phonological awareness was strongly and positively linked to reading acquisition (Stanley & Bryant, 1982). Children with good phonological awareness skills were found to be better readers than children with poor phonological awareness skills. From the many training studies that now exist, phonological awareness is independently, causally related to reading acquisition (Hall &

(Blackman, 1983; Bradley & Bryant, 1983; Bryant & Fielding-Hartley, 1991; 1993; Lundberg et al., 1988). Further, children with reading-deficits have been found to have deficits in phonological awareness (Bradley & Bryant, 1983; Fox & Bower, 1980; Stanovich et al., 1984). For example, Stanovich et al. found that kindergarten-children who were classified as late skilled readers could not complete a set of phonological awareness tasks, whereas late kindergarten with typical reading ability were at ceiling for the same tasks. Torgesen (1986) took the relationship further and said that children with dyslexia are "consistently more impaired in phonological awareness than in any other ability" (p. 6).

Phonological awareness is required for children to use an alphabetic script, which requires representing a target utterance in conventional sounds for reading and spelling (Blackman, 1987). When a child reads a word, he or she analyzes a sound in each letter and then joins the sounds together to form a word. Thus, a child needs to have knowledge of sound-letter correspondences, sound segmentation or words, and word blending skills. Similarly, to spell a word, a child must be aware of the individual sounds that make up a word (generally by segmenting the word into phonemes) and then selecting letters to correspond to each sound. Most children find these tasks to be easy, but children with reading impairment (and sometimes phonological impairment) find the tasks difficult (Blackman, 2000).

The relationship between phonological awareness and literacy is complex. Phonological awareness is not the only language deficit identified in poor readers. Several other factors have been correlated with poor reading ability, such as syllable knowledge, rapid naming ability, verbal memory, auditory discrimination, working

memory, and grammatical ability (Catts, 1996; Fuchs, Fuchs, & Voorn, 1996; Scarborough, Seiden, Goodenow, & Samuels, 1999). Torgesen, Buckwalter, Threlkoff, and Rodriguez (1998) reported that letter knowledge was related to the development of literacy skills and was a significant predictor of reading and spelling skills. Even though many factors potentially predict or influence early reading outcomes, Catts and Fey (1998) found that children's phonological awareness skills at kindergarten were the best predictors of second-grade reading ability when compared to other language and cognitive measures. Snyder and Damary (1997) reviewed phonological awareness research with respect to reading and language deficits and concluded that a phonological core deficit is the most prominent oral language deficit in children and adults who have reading difficulty.

No one phonological awareness task can best predict reading ability in children because the relationship between phonological awareness and reading emerges and evolves throughout the development of reading skill. As children develop the alphabetic principle (i.e., learn to match written letters with speech sounds), predictive relationships of phonological awareness and reading skill change (Goodenow, 2000). Snyder and Damary (1997) found that kindergarten children who were considered high at phoneme level skills. When kindergarten became proficient in the alphabetic principle, they moved from the syllable (onset/ rhyme) to the phoneme skills level. Liberman et al. (1994) proposed that orthographic experience changes phonological awareness skills and effects flow (e.g., phoneme level/distinctions). Katz et al. (1988) found that kindergarten children who had already begun to learn to read had greater success in a final consonant-identity task than age-matched children who had not yet begun

to read. For the kindergarten in the Snowy and Francis study, the onset-rhyme skill level accounted for more variation in reading ability than did phoneme analysis.

Stanovich et al. (1984) found that a group of phonological awareness tasks (better than any single measure) accounted for a large percentage of variability in the reading ability of first graders. However, no single phonological awareness measure had high predictive value. Stanovich et al. speculated that rhyme did not correlate with reading ability because the children performed all writing tasks on rhyme cards, preventing this skill from discriminating among the children in complex productive relationships.

Stankiewicz et al. (1988) reported that rhyme was not a good predictor of reading ability for 4- and 6-year-old children with and without speech impairments, but three other phonological awareness measures were good predictors of reading ability: alliteration

Rheme (e.g., producing words that begin with the same sound), phoneme deletion (e.g., deleting the initial sound from a word), and completion (e.g., producing a final consonant given the beginning part of the word) were good predictors of reading ability.

Stankiewicz et al. found that rhyme is rhyme does not guarantee a good reading outcome. They found that some 4-year-old children who could rhyme went on to learn reading difficulty-free, whereas many children with normal language development were not able to rhyme.

Rather than rhyme, Stankiewicz and Wells (1981) suggested that phoneme segmentation skills may be better predictors of reading and spelling development. Marie Perle (Snowling and Taylor (1987) investigated segmentation skills and letter name knowledge and found that the two skill sets together best predicted reading and spelling development.

The relationship between phonological awareness and literacy is intensive and complex (Wagner, Torgesen, & Rashotte, 1994). Reading and the development of phonological awareness are evidently connected. Ellis and Wilson (1982) asked children to use markers to count the number of phonemes in words. Older children (7- and 10-year-olds) who were familiar with the conventional rules of spelling used fewer markers for words that contained a larger number of letters (e.g., using three markers for *new* and two markers for *do* even though both words contain two phonemes). Torgesen and Wendle (1987) asked 6-year-olds to tag out the number of sounds in real and nonsense words. Real words that contained digraphs had "excessant" marks that reflected influences of the orthographic knowledge.

Reading and spelling are linked in the literacy acquisition process (Catts & Kover, 1999). Not surprisingly, phonological awareness plays a role in spelling and also in reading. Researchers have long indicated that phonological awareness is required for adequate spelling (Ball & Blachman, 1980; Ellis, 1982; Gormican & Bryant, 1989; Lundberg et al., 1988; Torgesen, 1984). Fuchs(1984) proposed a developmental path of spelling acquisition in which children progress from a logographic stage of matching written whole words to their spoken forms to an alphabetic stage (during which they use the principles of phoneme or phoneme correspondence between sounds and letters). As children move into the second phase of spelling acquisition, spelling is based on knowledge of a word's phonemic structure, not children share phoneme use of corresponding letters to represent sounds. They can also apply knowledge of letter sounds and segmenting to spell. In the last stage (the orthographic stage) children are able to learn conventional spelling rules that replace complex phoneme level spellings.

and to recognise orthographic variations, such as prefixes and suffixes. (Scribner [1991])

model of reading and spelling acquisition is that children first show skills at a logographic stage, recognising words by rote memory. Next, in the phonetic stage, children acquire some phonetic awareness skills and use nascent knowledge of sound-letter correspondences to link spelling and pronunciation. Finally, in the alphabetic stage, children use all letters and phonemic identifications of a word's pronunciation to link letters with phonemes and allow pronunciation of sequence. Both models indicate that children become better spellers as their knowledge of phonemic awareness improves, and that as they learn conventional spelling rules.

Some recent studies confirm the central importance of phonological awareness to spelling. Clarke (Klein and McGee [1995]) found that poor spellers also had poor phonological awareness skills. Saxon and Hulstijn [1997] found that phonological awareness was the best predictor of spelling ability in elementary school.

Evidence also exists that a child's phonological production system affects spelling development. Torgesen [1997] asserted that a child's spelling provides information on the nature of the child's phonological system. "It revealed us how they segment sounds into larger units, such as syllables and words, which sounds they consider to be similar to one another, and which sounds they consider to be different" (p. vi).

Relationship between expressive phonology and phonological awareness

Expressive phonological awareness involves the identification and manipulation of syllables, minimally pairs, and phonemes (which are units of phonology as opposed to syntax or morphology). The hypothesis that expressive phonological production ability and phonological awareness are closely related has been explored

Several studies linked severely impaired phonological production to deficits in phonological awareness (Buckwalter, et al., 1999; Dahl et al., 1998; Reid and Bishop, 1993; Webster & Plante, 1992).

Various theories of phonological processing attempt to account for the link between expressive phonology and phonological awareness abilities. Fowler (1980) proposed a phonological deficit hypothesis. She speculated that early delays in phonology could adversely affect the development of underlying phonological representations and lead to later phonological awareness difficulties. Phonological representations are stated initially as whole units, but the representations become "increasingly segmental" well specified and accessible (as Buckwalter & Wells, 2001, p. 265). This explanation implies that underlying representations for phonological units are the same whether they are accessed for phonological production or phonological awareness.

Other psycholinguistic theories have also been used in explaining the relationship between phonology and phonological awareness. The articulatory loop model proposed by Baddeley and Hitch (1974) has been used in explaining how expressive phonology could be linked to phonological awareness (Webster & Plante, 1992). The Baddeley and Hitch model proposes that subvocal rehearsal is used to hold and manipulate phonological information in working memory. Based on this, Webster and Plante hypothesized that if children have deficits in phonological production, they may not use covert phonological representations in the loop, which would affect how phonological units are stored in working memory. Fully representation in working memory would

negatively affect performance on tasks requiring manipulation of an item stored in working memory and could therefore affect phonological awareness and reading ability.

Based on research by Snow and Germaine (1987), Lammert and Cain (1995) also asserted that problems with the quality of the underlying representations could lead to phonological awareness deficits. Snow and Germaine investigated the nature of children's underlying representations by having children name pictures of objects. The authors compared the children's distinct to-ambiguous words that were produced correctly versus those produced incorrectly. They found that children's ambiguous words produced accurately better than they reproduced words produced inaccurately. This led them to conclude that phonological analysis skills depend on the accuracy of underlying representations of words.

Backhouse and Wells (1987) used a psycholinguistic model of speech processing to account for the relationship between phonology and phonological awareness and proposed that the speech processing system must be intact for normal speech development, and the normal development of written language. Speeches input enters the system through auditory input, it is stored as a lexical representation in memory, and it is recalled to produce speech output. Incomplete or incomplete mental representations hinder when a child is forced to rely on his/her own representations to complete the task. For example, if a child with an incomplete or inaccurate mental representation is asked to perform a task such as rhyme production or sound blending, the child must reflect on his/her lexical representation to retrieve verbal information in memory. When preparing to speak or spell, the child must reflect on the structure of words and incomplete mental representations should lead to errors on these tasks. The speech processing system does

the basis for speech development and literacy development, with written language explained as an extension of spoken language. Phonological awareness does not exist as a separate area of development, but as a product of speech processing skills, so difficulty with the speech processing system will result in spoken disability and disruption of phonological awareness development. Disruption of the system can occur at either the input or output level. Swadlow and Walk repeated phonological awareness tasks on “input tasks” and “output tasks” to give them a corresponding position in their speech processing model. As a result of their work with the speech processing model, the authors proposed a level of language development called the morphophonological stage during which children are ready to match spoken output with print.

The nature of linguistic knowledge and literacy has often been addressed with respect to spelling acquisition. McCormick (1991) hypothesized that many of mental operations govern both spoken language development and written language. During literacy development, children’s explicit knowledge of words becomes applied as they learn to associate sound patterns with their orthographic counterparts. In acquisition of spelling, children are forced to “mentally represent relationships and regularities between linguistic units they had not previously discovered” (p. 123). McCormick posited that this structure requires re-representation of linguistic knowledge, which could account for improvement in phonology awareness ability during literacy acquisition.

Phonology and Phonological Impairment

Phonology is the branch of linguistics that represents the sound system of spoken language. It refers specifically to the organization and classification of speech sounds that occur in a particular state in a given language. In a broader sense, phonology can

refer to all aspects of the study of speech sounds, including speech perception and production, cognitive, and motor aspects of speech (Stead-Gammon & Dunn, 1984).

Although phonological acquisition is nearly completed by the time a child begins attending school, young school-age children have not fully acquired the phonological system used by adults. Most investigations agree that children complete their phonemic inventory by age 7-8 (Berman, Whangler, 2004). However, in addition to presenting difficulty with a few less-acquired phonemes, Best (1982) found that the production of consonant clusters remains difficult, and cluster productions for 7-year-old children are often not adult-like. Ingram (1976) noted that children up to 7 or 8 years of age are still completing their phonemic inventory with late-developing sounds, and that they often produce longer words, such as *elephant*, incorrectly.

Children with phonological impairment have difficulty acquiring the sounds or the sound system of their native language (Stead-Gammon & Dunn, 1985). Berman Whangler (2004) described phonological impairment as an impairment of the representations and organization of phonemes in a language system. Although some children with phonological impairment do not have any other accompanying language impairment, approximately 75-85% of preschool children with articulation or phonological impairment also have a language disorder (Shriberg & Kwiatkowski, 1998).

Some researchers make a distinction between phonemic and phonological impairment. For example, Gammon (1987) described persons with a phonemic disorder as producing distorted sounds, allophone variants of sounds, or sounds not found in the native language inventory. By comparison, persons with phonological impairment

produce well-formed words that are appropriate for the context. Further, the view that is, *in some cases*, phonetic difficulties go along with phonological impairment. Gierling and Karavolos (1982) recommended that the term *phonological disorder* be used to refer to any problem with the speech production process that impacts articulation and phoneme organization.

Researchers have used many aspects to describe children with phonological disorders or impairments, because there were well-defined groups of children that can be classified without multiple descriptors. Sadi, Quensen and Davis (1982) conducted a meta-analysis of researchers' descriptions of children with phonological impairment and identified a set of differences most frequently described. These include characteristics that place a child well behind in progress toward mastery, variability in production without improvement in production, persistence of phonological processes beyond the ages of occurrence in normally-developing children, chronological mismatch between co-occurrence of processes used and correct production of late-acquired words, use of idiosyncratic rules in production, and extended use of contrast (Garnswell, 1987).

According to Garnswell (1987), phonological impairment describes a vocal system that is delayed, atypical, or deviant. Delayed phonology follows the same developmental path as typically-developing phonology but, compared with chronological age, appears to be like the phonology of a younger child. For example, a child may continue to use phonological processes typical of a younger child. Deviant phonology describes use of phonological patterns that do not occur in typically-developing children. Although Garnswell proposed this typology, she also acknowledged that some normally-developing children also use processes idiosyncratically.

Phonological analysis

Several authors have described phonological analysis in terms of the following components: inventory and distribution of speech sounds, syllabic stages and constraints, phonological constraints, and phonological error patterns (Eiseman-Wongler, 2004; Elbert & Green, 1986; Greenwell, 1987). In addition, there are several phonological approaches to analysis (through use of descriptive features analysis, constraint analysis, and phonological process analysis (Eiseman-Wongler).

Paul Gannon and Green (1985) described two different approaches to analyzing children's phonological productions: independent analysis and relational analysis. Independent analysis is often used to evaluate emerging phonological systems, and the child's system is described without respect to the adult model of a word. In a relational analysis, the child's production is compared to the adult form. The child's form can be directly compared to the adult form in terms of phoneme development, word shape and process use. Phonemic analysis and process analysis are both widely used, and both appear in published texts of articulation and phonology.

Within the framework of relational analysis, process analysis allows a systematic approach to analyzing errors based on adult targets. Process analysis evolved from Stangor's Natural Phonology theory (1969, 1971), which proposes that all children use phonological processes as a normal and natural part of normal phonological development. As their phonological abilities mature, children learn to suppress processes that do not occur in their native language. Stangor described processes as levels of noise that affect syllable structure such as weak syllable deletion and final consonant deletion, and substitution processes that involve substitution of one sound class for another (e.g.,

stopping fricatives or liquid gliding). Stamps's proposal assumed that a child's production was based on the whole phonemic form of a word and was intended to be both descriptive and explanatory in nature. Ingram (1974) expanded on Stamps's work to emphasize the systematicity of children's phonological productions. He defined a phonological process as a descriptive rule that can account for series of substitution patterns, or alliterations. The classification of processes was used to describe the ways in which children simplify adult targets. The implication was that a child who follows the first consonant of a word knows that the adult form of the same word contains a first consonant, but, for cognitive, motor, perceptual or linguistic reasons, the target is simplified by the child. The assumption inherent in this perspective was that children's productions have a one-to-one correspondence with adult forms and are "simpler" than the adult target. Applying the child's forms to adult forms has remained a primary criterion of using phonological processes to describe child phonology (Ellert & Gierst, 1988; Sweet-Grosvenor & Davis, 1989).

Despite earlier controversy over the nature of processes, many researchers continue to use process analysis to describe and remediate children's error patterns. For example, Hudson and Pickett (1987) used the term phonological process to identify errors that were word phoneme classes and syllable structures, without any assumption about a child's underlying representation of a word. Their popular phonological overspecification approach, called the Cycle approach, targets error patterns related to phonological processes rather than individual sound errors. When process analysis is not used to map underlying representations to a child's production, the descriptive

However, research useful in describing broad error patterns that affect word classes or go across word classes to affect syllable or word shape (Edwards, 1987).

Measurements in phonology

Phonological impairment is not diagnosed with one specific procedure or method. It can be diagnosed based on a comparison to normed data for word acquisition, intelligibility ratings, persistent use of phonological processes, incomplete phonetic acquisition, or incomplete acquisition of syllable or word shapes (Barnard & Jackson, 2004). It is probably most commonly diagnosed by administering a single-word articulation test, such as the *Goldman-Fristoe Test of Articulation* (Goldman & Fristoe, 2000), in addition to any other measures administered or analysis approaches used.

Phonological production can be measured by analyzing words in recorded speech samples, which is the preferred method for many researchers. However, this method is very time consuming, and can result in data that is not consistent when evaluating several children. Speech samples can vary significantly from child to child, and it is difficult to elicit all speech sounds in all word positions through conversation or play without providing some structure, such as objects or pictures for a child to name during the conversation.

There are several published tests of articulation and/or phonology targeting single words. These tests evaluate all the consonants of English in different word positions: onset, commonly initial and final, and sometimes medial. The words are elicited using pictures of nouns, subjects, and seasonal verbs. There are several standardized tests of articulation and phonology; for example, *Goldman-Fristoe Test of Articulation* (Goldman

A.Prosody, 2000), *Arctic Articulation Proficiency Scale* (Feldata, 2008), and *Real World Articulation and Phonology Evaluation* (Smit & Ford, 1997). In the construction of these tests, authors based diagnosis of a phonological disorder on comparison of a child's production to norms for sound acquisition and fluency from the same or similar scenarios. Such articulation tests are often criticised for being incomplete because they do not address performance in connected speech. However, they are quite useful in eliciting a variety of sounds quickly and reliably from subject to subject, and they are time efficient to administer and analyse. Another weakness of this type of evaluation is that nonsense/nonce words, which are typically used on articulation tests, do not elicit overt and covert/latent phonological processes, such as assimilation, neutralisation and word syllable deletion (Catts, 1984).

When a speech sample is used to analyse phonological ability, a sample of at least 60 to 100 words is recommended (Smit-German & Dean, 1983; Grinstead, 1987). This allows for multiple exemplars of sounds to assess variability of production, and a good strategy of all consonants in different word positions. Most tests of articulation can also be used to analyse phonological process-occurrences with the set of words elicited on the articulation test, however, few tests provide the 60-100 words recommended for analysis. Also, few tests are designed explicitly to analyse phonological processes and provide normative data for them, though there are a few tests that are useful. The most widely used normal phonological process tests are the *Analysis of Phonological Processes Revised Edition* (Phillips, 1989), *Child-Lewis Phonological Analysis Revised Edition* (Chen & Lewis, 2002), *The Revised Revised Test of Phonology* (Buckton & Buckton,

1992), *the Iowa Read Articulation and Phonology Evaluation* (Sext & Hunt, 1997), and *the Clinical Assessment of Articulation and Phonology* (Sext & Johnston, 2002).

Percentage of Consonants Correct (PCC) is a measure of severity of phonological disorder developed by McHenry and Kozlowski (1981) to quantify degree of disorder. The authors developed this metric to use for the calculation and found that the PCC results correlated closely to listeners' perceptions of severity. The PCC measure is based on a five- to ten-minute conversational sample and is a simple subtraction of number of correct consonants in the sample divided by number of correct plus incorrect consonants multiplied by 100. Deletion and substitution of target consonants, and addition to target words, and devoting or distortion of a sound are considered incorrect. This measurement is frequently used in the literature to describe the severity of phonological impairment.

Research in reading disability, most notably Catts and colleagues (Catts, 1994, 1996, Lammie & Catts, 1994) have used articulation word distortion to assess phonological ability in comparison with typical single word articulation tests. Catts (1996) showed that adolescents with reading disability made more errors in naming pictures with complex phonological segments (e.g., *thermometer*, *elephant*, *unbalance*) than their age-matched peers. He also found that specific types of phonological errors on these tasks (mostly word syllable deletion and assimilation, correlated with reading problems. Magnusson and Skaderis (1992, 1994) found that children with segmental errors, such as misstatements and mispronunciations, were more likely to have reading problems than children who had primarily suprasegmental problems, such as substitution and deletion. These findings are important to the reading research literature

and they reflect a deficiency of typical articulation tests, which is the absence of complexity. Gata and Rando (1990) identified difficulty with complex words as a potential deficit in phonological memory. Incorporating a multisyllable word task into a phonological assessment may allow analysis of error patterns that would not otherwise show up during a speech evaluation.

Studies in Phonological Impairment and Phonological Awareness

There are some examples in the literature that clearly show a link between expressive phonology and phonological awareness. However, these examples do not show a consistent or direct relationship, such as one would expect with the models outlined above. Hesketh, Adams, Hightopple, and Hall (2000) recently summed up the problem of identifying the relationship between phonological awareness and phonological production by saying, "There are good speakers with poor metalinguistic skills and poor speakers with good phonological skills" (p. 340).

The issue of the phonological impairment plays a role in whether children also have phonological awareness deficits. When articulatory difficulty results from peripheral neurological damage, such as in dyspraxia, or structural anomalies, such as cleft palate (Bishop, Ryan Brown, & Ralston, 1990; Jackman, 1982), phonological awareness remains intact. However, severe developmental apraxia of speech (Dyspraxia) does appear to be linked to phonological awareness deficits (Jackman, 1980). Jackman (1997) discussed case studies of two children with severe phonological impairment who had symptoms of developmental verbal dyspraxia. She found that the children, ages 10:7 and 11:6 at the time of testing, had difficulty with rhyme production

when presented with stimuli visually rather than orally. Differently with rhyme production, spelling was not significantly correlated with oral rhyming, $r = .14$, $p = .11$.

Research from spelling indicates a link between phonological awareness and phonological production. Children in a study by McCloskey (1981) had spelling error patterns that corresponded to their use of phonological processes. Children who used phonological processes in speech consistently used spelling error types that corresponded to their use of processes in speech. Other studies that investigated the spelling abilities of children with phonological impairments reported that they perform more poorly than children without phonological impairment (Charles Klein & Hodson, 1985; Dodd & Corkin, 1982).

A few longitudinal studies have shown clearly that there is a link between expressive phonology and phonological awareness. Walaker and Plante (1984) followed their young subjects over time and found that children who initially had low phonological skills also had low phonological awareness skills. As the subjects increased in speech intelligibility, their phonological awareness skills increased correspondingly after accounting for maturational development. Hesketh et al. (2008) conducted a phonological treatment study and found that as speech abilities improved during therapy, metalinguistic abilities also improved, regardless of whether therapy directly targeted phonology-awareness. From research on spelling and phonological disorders, Charles Klein and Hodson (1984) found that a history of disordered phonology accounted for a significant proportion of the variance in phonological awareness scores. These studies provide evidence for a link between expressive phonology and phonological awareness.

In a consistent study, Marlow, Paine and Ellis (1999) the relationship between expressive phonology and phonological awareness remains less clear. The authors experimentally trained phonological awareness and phonological production and measured lexicons and reading gains during treatment. They found there was no demonstrated relationship between phonological awareness and phonological production. Improvements in one variable did not always lead to improvement in the other variable, and phonological production gains were more often cut than gains in phonological awareness.

Studies that examine research indicate that the phonology/phonological awareness relationship is not very clear. This studies from research on reading and phonological awareness indicated that phonological impairment and phonological awareness may not be linked in a direct way. Contrary to the expectation that phonological awareness is responsible for successful reading acquisition, Lervin and Catts (1999) found that phonological awareness scores could not account for variance in reading ability in a group of children with phonological impairment. Instead, they found that a measure of percent of consonants correct (PCC) in unscripted words accounted for a greater portion of the variance in reading ability than scores on phonological awareness tasks. This finding raises the question of the nature of the relationship between phonological awareness and expressive phonology. An earlier study by Bishop and Adams (1990) found that deficits in expressive phonology did not correlate with early reading ability in children with phonological disorders alone. This leads to the question of whether phonological impairment actually correlates with deficits in phonological awareness.

Care (1981) examined reading abilities of children with language impairment and found that children with low language ability and low phonological awareness wrote/produced the poorest on a set of reading tasks. Studies by Bishop and Adams (1990), Lewis and Proctor (1992), and Zurek et al. (1993) also found a link between low language ability and low phonological awareness scores. In a 1997 study by Lonan et al., children with language impairment and speech impairments performed the poorest on two phonological awareness tasks. This body of research suggests a possible link between phonological awareness and language in addition to, or perhaps, rather than phonological production.

Given this knowledge, to evaluate the role of expressive phonological ability in phonological awareness, it is essential to investigate children with phonological impairments only. However, including children who also have language impairments has complicated most of the studies that have investigated phonological production and phonological awareness. To date, only a handful of studies have looked at the relationship between phonological production and phonological awareness. These studies point to a general finding: children with more severe phonological impairment perform more poorly on tasks of phonological awareness. However, it remains unclear how phonological impairment affects ability to perform on phonological awareness tasks. Lonan et al. (1997) showed that some children with phonological impairment appear to have no difficulty with phonological awareness tasks.

The first study to examine this relationship was Reid and Bishop (1992). The authors studied 28 children between the ages of 3;0 and 4;3, with a mean age of 3;8. Fifteen of the children had a diagnosed phonological impairment, based on a score

Index (IPA) was distinctive. Index analysis of phonemes produced in 100-syllable words. Fifteen children with normal phonology were matched on sex, chronological age and corrected ability, and all children in the study had normal language comprehension. Expressive language ability was not assessed for in this study, so no determination can be made whether children with phonological impairment also had expressive language difficulties. Experimental tasks included two auditory discrimination tasks, two phoneme-matching tasks, a rhyme production and a rhyme judgment task.

The earliest found significant differences between the control group and the phonologically impaired group in discrimination of real words and non-words. Significant differences were also found in the rhyme judgment and rhyme production tasks but not on the phoneme-matching task. Children with phonological impairment had greater variability on all of the tasks, though some children did perform in the normal range, and children in the two groups appeared to have different strategies for choosing rhyming words. One interesting finding that resulted was that corrected ability correlated with severity of phonological impairment, even though all children measured in the normal range for corrected ability. This study was the first of its kind to measure the relationship between phonological production and phonological awareness directly and it was well designed with matched controls. However, children were given only non-rhyme level tasks, and many of the tasks involved a binary choice (Do you hear the sound in the word?). In the measure were not very robust. A 30-word sample was used for the phonological analysis, and there were no measures of connected speech or complex words, and as noted above, expressive language ability was not measured.

Wolman and Plante (1991) studied the relationship between phonological impairment and comprehension ability and reading in a group of 22 children (mean 5;5-5;8 years old). Eleven children had been diagnosed with persistent evidence to suggest expressive phonological impairment, and were matched for mental age with 11 children with normal phonology. Nine of the 11 children in the group with phonological impairment also had deficits in expressive syntax or morphology. The group with phonological impairment was diagnosed by 100% or less intelligibility ratings and greater than 30% use of two or more phonological processes measured by the *Class-Lexon Phonological Analysis* (Ramus & Lavoie, 1985). Children were given tests of comprehension both on discrete sentences to words, words to syllables and words and pseudowords to words. They were also given a test of written word recognition on single print words.

The authors found that children with normal phonology performed significantly better on three comprehension tasks: word-phoneme, sentence word, and pseudoword to word. For the word-syllable task and the reading task, no significant group differences were found. Again, greater variability in phonological impairment index was observed in the group with phonological impairment. The authors also found some interesting correlations between independent and dependent variables. Speech intelligibility was found to correlate with pseudoword comprehension and word-phoneme comprehension. It is difficult to determine the homogeneity of the group with phonological impairment, as language ability was not controlled in this study. Phonological assessment tasks of only one type, comprehension, were administered, but the tasks did reflect a variety of levels of difficulty from word to phoneme.

Benzhardt et al. (1996) studied a group of twelve younger children, from 1;8 to 2;0 years old. Twenty children aged 1;9 to 2;11 with normal phonology, morphology and expressive language and articulation were compared to a group of 11 children, aged 1;6 to 2;0 with phonological impairment but normal receptive language. Ten of the 11 subjects in the phonological-disorders group also had delayed language production. Children were given a battery of phonological awareness tasks, including nursery rhyme knowledge, rhyme production, sentence division, monosyllabic division, disyllabic division, alternative production and a task for "changing names" in which children assigned new names to objects.

Group differences were found, but findings were not consistent from task to task. Both groups had difficulty with alternative production and monosyllabic division, but some of the children in the phonological-disorders group outperformed children in the normal phonology group on sentence division and disyllabic division. Benzhardt et al. (1996) were able to show order effects for task administration in the division tasks, with a practice effect occurring when tasks were ordered by sentence, disyllabic, and monosyllabic. Descriptions of the children's phonological systems were very limited. Nonlinear phonological analysis had been used to assess children's phonological ability as descriptions were limited to broad severity ratings, and the authors noted that all subjects had limited representational inventories and reduced word and syllable shapes. Although many of the children in the group with phonological impairment also had expressive language impairment, the effect of the language impairment on phonological awareness was not isolated or discussed.

Best et al. (1999) conducted a longitudinal matched-pairs study of 45 children between 5 and 7 years of age at the study's inception, with and without phonological impairment, on measures of phonological awareness and literacy. They tested the children on three occasions over a 17–20 month period. All of the children had normal nonverbal ability. Of the 30 children in the group with phonological impairment, 21 subjects had corresponding language impairment. Phonological assessment was conducted using a picture naming test of an unspecified number of words. Phonological awareness measures included rime matching, onset matching, and a task of onset segmentation and matching. Letter name identification and letter sounds were tested, a reading test, and a spelling test were administered, and word-level reading and word-level spelling tests were administered.

At T1, children with phonological impairment performed significantly poorer on phonological awareness tasks than children in the normal phonology group. At T2, the differences were still significant, but by T3, all of the children approached ceiling on onset matching and onset segmentation and matching. Curiously, this study did not show a correlation between the phonological awareness tasks and the literacy measures. Subjects ranged from 54 to 74 at the study's inception, which is a large age range to consider a homogeneous group of children during the developmental phase, as children in this age group could span more than two grade levels, and grade level of children was not specified. Phonological awareness tasks did not address the phoneme level, only the onset, rhyme level, and as ceiling-level performance on tasks was approached, group differences faded, illustrating the need for more discrete phoneme-level measures of phonological awareness, particularly as children get older.

Wolter and Marks (1981) expanded on their previous study to investigate phonological awareness and phonological production abilities longitudinally. They were able to show a positive relationship and developmental trend between phonological awareness tasks and phonological ability. They studied 41 subjects with a beginning mean age of 3;6 (range 3;0–4;0). Twenty nine of the subjects were identified as phonologically delayed. All of the children had normal nonverbal intelligence and receptive language scores. Children were administered the *Kline-Lewis Phonological Analysis* (Kline & Lewis, 2000) at baseline and every six months for three years. They were also given two phonological awareness tasks, alliteration detection from three pictures and rhyme detection from three pictures.

By age 3;6 most of the children had passed the alliteration task, and by 4;0 they had passed the rhyme task. Rhyme and alliteration were the only tasks administered, as it was not possible to evaluate a developmental trend across levels of tasks. Later when phonological awareness abilities, children were presented three stimuli and asked to eliminate the one that did not match the other two, resulting in a choice-cells or match item and then, into a very robust measure. Statistical analysis on this study consisted of Logit analysis, which was designed to predict the probability of one outcome given two sets of scores over a period of time. From this example analysis, the authors concluded that children with lower phonological production scores had a lower probability of passing the phonological awareness tasks. The results reflect the expected findings of the two tasks of the range, mild phonology and severely impaired phonology but do not shed any light on the nature of the relationship between phonological awareness and expressive phonology for most of the subjects.

Lafuze et al. (1987) looked at segmentation and blending skills and invented spelling ability in four groups of twenty 4-year-old children: speech impaired, language impaired, speech and language impaired, and normal language abilities. They found that the children with speech and language impairment performed the worst on the tasks, but that the group with speech impairment did not perform and the children with normal speech and language. More importantly, the speech impaired group did not perform uniformly. Half of the children in the speech only group performed within normal limits, and the other half had impaired ability to perform the segmentation and blending tasks, and the invented spelling task. In a post hoc analysis of children with speech impairment, the authors did not find a relationship between expressive language scores and phonological awareness in these children or between severity of speech impairment and phonological awareness scores.

The authors were able to apply a framework developed by Dodd (1983) to place children into three groups: delayed, accelerated, normal, and lowest production. When these groupings were applied, 9 of 11 children who had low scores on the phonological awareness tasks were described as having lowest phonological production. This led the authors to propose that the nature or subtype of the phonological impairment places children at a particular risk when their present use is delayed rather than delayed. Although the authors included a picture-naming task as their independent variable, they did not analyze that task with respect to phonological awareness and instead looked at it as a dependent variable, with the finding that children with speech impairment did poorly on the task compared to children with normal language skills. The failure to use these data constructively is a loss of potentially valuable information that could

link children with poor language and poor speech to their performance on phonological awareness tasks.

Kjäger and Benasich (1996) investigated morpho-phonological skills and the effects of intervention on those skills of 19 children 3 to 5 years of age identified with markers to severe phonological disorders. Severity of phonological impairment was based on a measure of PDC that rated markers to severe. Children completed several tasks of phonological awareness, including rhyme production with context, rhyme production without context, nonsense division, monosyllable division, alternation production, and changing names. The investigators found that several phonological measures, such as percent consonants correct, percent vowels correct, and word shape match, correlated with total morpho-phonology (phonological awareness) scores. Children with limited word shape had difficulty with the morpho-phonology tasks.

As in other studies, a wide range of individual variation was observed, and some children with phonological impairment performed well on the tasks. Children who had good morpho-phonetic production and severe phonological disorders performed poorly on the morpho-phonological tasks. If morpho-phonetic skills were good, then morpho-phonology was weak. Children with similar phonological profiles performed differently on the tasks. Like earlier studies, this study confirmed that children with more severe phonological impairments perform more poorly on phonological awareness tasks, but it failed to replicate good phonological awareness in children with phonological impairment. Regression analyses were used to determine the influence of morpho-phonetic deficits on phonological awareness, and it was determined, as expected, that impaired syntax and morpho-phonetic correlates with phonological awareness. Children with severe

phonological disorders and good productive syntax but variable performance on the tasks, and children with both severe phonological and morphosyntactic impairment performed the worst on the tasks.

Larson and Cain (1989) studied the effects of phonological impairment on reading ability in 57 children between the ages of 3;4 and 7;5. Two groups of children were compared, one group of 30 children with phonological impairment, and a group of 27 children with normal phonology. In the group of children with phonological impairment, 18 of the 30 children also had language impairment more than one standard deviation below the mean on two of three measures which measure language measures. Phonological ability was measured by the *Denver Articulation Proficiency Scale*. Children were tested on a battery of phonological awareness measures, a multisyllabic word production task, and a word repetition task, and two reading subtests administered at a second time. Children were asked to segment words in syllables, identify alliteration from a set of three words, blend phonemes to identify one of three pictures, and judge whether a word was heard as a particular word. 'Do you hear /s/ in *snip*?'.

The results from this study are of limited value in understanding the contribution of phonology to phonological awareness because regression analysis was not made between the two variables. However, some interesting findings did emerge. The group of children with phonological impairment did not perform uniformly on the reading tasks and they were divided into two groups of good and poor readers. The measure that accounted for most of the variance in the reading scores was the multisyllabic PCT measure rather than the correlation between the phonological awareness measures

The group of poor readers had lower scores on reading/label PCC, phonological awareness, and language measures. The correlation between reading/label PCC and reading could indicate one of two possibilities, a more complex phonological awareness, such as the PCC, is needed to identify children with deficits in phonological awareness and production/phonology or phonological production and phonological awareness are not closely linked for children who are moderately phonologically impaired with no concurrent language impairment.

Summary

Although researchers have made some gains in establishing a direct relationship between phonological impairment and phonological awareness, it is still unclear which children with phonological impairment will be at risk for reading difficulty. Although children with severe phonological impairment have been found to have phonological awareness deficits in several studies (Bernhardt et al., 1996; Best et al., 1999; Carver et al., 1997; Major & Bernhardt, 1998; Webster & Plomin, 1992), no determination could be made for children with moderate phonological impairment. It would be very beneficial to identify children with moderate phonological impairment who are at risk of phonological awareness deficits and potential difficulty with literacy acquisition before they begin to struggle with reading and spelling instructions. Therefore, it is a valid undertaking to pursue this line of research to determine what group differences (between children with and without phonological impairment).

Bernhardt et al. (1996) reported that it is difficult to draw conclusions about development of phonological awareness in children because so many testing paradigms have been used. Similarly, methodological issues have clouded the ability to reach

conclusions about whether children with phonological impairments also have phonological awareness deficits. Some of the methodological problems presented in earlier studies include the selection of subjects based on level of standardized articulation tests and lack of phonological awareness available for post hoc regression analyses with phonological awareness tasks. Language impairment confounding results in children with phonological impairments, use of subject across broad age ranges, use of non relevant measures and confounding effects on measures used, lack of a range of phonological awareness tasks across linguistic and ability levels, and a lack of measures to control for motivational differences in children.

To definitively test phonological awareness and phonological production it is necessary to look at children who are still in the process of developing skills in both areas and to use measures that will provide suitable ranges of ability for both task areas. Most researchers have administered a limited range of phonological awareness tasks rather than a set of tasks designed to uncover a developmental profile. Bernhardt et al. (1994) administered a wide range of tasks, as did Meyer and Bernhardt (1994) but their results were confounded by language impairment and a limited range of subjects tested (3 to 6;6). Watson and Plante (1982) looked only at segmentation, although they did investigate both syllable and phoneme levels of the task. Their 1981 report considered only rhyme and alliteration, and their statistical analysis did not provide specific information on task performance with respect to phonological production. Levine et al. (1987) also used a variety of tasks (segmentation, blending, and reversed spelling) but they did not compare results of these tasks with the sample phonological production task. Therefore, it is unclear whether this comparison could differentiate the two groups

of speech impaired children who performed differently on the phonological awareness tasks.

Measures of phonological production used to select subjects for testing here, for the most part, have single-word naming tasks that are standardized articulation tests (e.g., *The Goldman-Fristoe Test of Articulation*). These tests have not measured any of phonological processes, word shape characteristics, or production of complex multi-syllable words. Excepted is the test the studies conducted by Burchard and colleagues (1996, 1998). By using a variety of phonological measures to screen for the types of processes that have been associated with phonological awareness impairment, it is more likely that children with moderate phonological impairment can be segregated into those who are at risk for phonological awareness deficits and those who are not.

As shown in several studies (Bishop and Adams, 1998; Cain, 1993), it is crucial to select language-impaired and develop only phonological impairment to determine which children with phonological impairment have phonological awareness deficits. In addition, testing children at age ranges that span more than one corresponding academic year can lead to a large degree of variability in performance depending on the child's exposure to the alphabetic principle through reading and spelling instruction. Of previous researchers investigating the relationship between phonology to phonological awareness, the only ones who selected subjects within a one-year age bracket were Lewis et al. (1987). Bird and Bishop (1992) had a 15-month age span for their subjects. All other researchers had age ranges of more than 18 months for their subjects (Burchard et al., 1996; Bishop et al. 1993; Lammey & Cain, 1993; Major & Burchard, 1994; Walster &

Platts, 1992, 1993). Most of these studies used control subjects matched for classroom environment (same kindergarten/classroom).

Symptoms of the Problem

It has been shown that not all children with phonological impairments perform the same on tasks of phonological awareness. Children with severe expressive phonological impairments have been found to perform more poorly on tasks designed to measure reading readiness than children with moderate or mild phonological impairments. They show weaker phonological awareness skills than children with moderate phonological impairment.

It is important to identify all children at potential risk for reading difficulty even when identifying them as children or as not currently evaluated, so that early intervention can be provided. Because early intervention can remediate reading difficulty in all but the poorest of readers, it is critical to identify children as early as possible and refer them for phonological awareness training to avoid future academic difficulty. Primary objective is determine whether children with phonological impairments have weaker phonological awareness skills than normally developing children have revealed mixed results, indicating that some children with phonological impairment perform poorly, but others do not.

In this study, a battery of phonological awareness tasks to target syllable, onset-rhyme, and phoneme level, was developed. Tasks were also constructed with consideration to frequency influences on task difficulty, providing a range of tasks that can provide a more accurate measure of phonological awareness than previously measured. Additionally, confounding variables of expressive language ability, nonverbal

ability, receptive language ability, and age were controlled in the test design. To rule out differences due to educational exposure, control subjects were recruited from the same kindergarten classrooms as children with phonological impairment. Phonological production ability was assessed in a variety of ways, all of which have been found to influence phonological awareness in previous studies. Phonological awareness procedures were chosen because they have been shown to be predictive of identifying children at risk for reading difficulty in the early school years.

The following experimental questions were addressed:

- **Question 1:** Do children who have phonological production deficits, without accompanying language disorders, perform the same as a control group of normally developing children on a battery of phonological awareness tasks?
- **Hypothesis 1:** Children with phonological production deficits will show lower scores on phoneme awareness tasks than their grade and classroom matched controls.
- **Question 2:** Do specific phonological measures (e.g., percentage of consonants correct or error patterns (e.g., syllable deletion) overlap with overall phonological awareness (e.g., rhyming + alliteration + phoneme deletion) and with specific tasks of phonological awareness (e.g., rhyming)?
- **Hypothesis 2:** Degree of diverse phonological patterns will correlate with total phonological awareness scores. The higher the degree of phonological production deviancy the lower the phonological scores will be.
- **Question 3:** Are there phonological error patterns that overlap with specific phonological awareness tasks?

- **Hypothesis 3:** Some phonological awareness tasks, particularly those at the phonemic level of awareness, might be replaced by phonological production difficulties.
- **Question 4:** Do children with and without phonological impairment exhibit the same order of difficulty on a comprehensive battery of phonological awareness tasks that measure constructs from the syllable level to the phonemic level of analysis?
- **Hypothesis 4:** The two groups will find syllable level tasks easier and phonemic level tasks most difficult.

CHAPTER 2 METHODS

The purpose of this study was to compare the performance of kindergarten children with and without phonological impairment on a series of phonological awareness tasks. The primary research questions addressed in whether young children with phonological disorders, but no known language disorder, show differences in phonological awareness skills when compared to peers matched for age, spoken language, and cognitive ability. A battery of phonological awareness tasks was administered to all students in each of the two groups. This chapter includes information on the subjects, measures, equipment, procedures, stimuli, scoring, and analysis.

Subjects

A total of 30 subjects, 12 males and 18 females, participated in this study. Ten of the children recruited for this study had expressive phonological or articulation disorders (PD group). They were matched with ten children with no typically developing articulation and phonology for nonverbal intelligence, expressive grammar ability, and chronological age (CV group). Subjects ranged in age from 5;8 to 6;8, with a mean age of 5;2 years. All of the children lived in Palm Beach County, Florida, and attended kindergarten classrooms in public schools in the District District of Palm Beach County or private schools in Palm Beach County. The mothers' educational level ranged from 11 to 19 years, with a mean of 14 years.

To be included in the study, children in the experimental and control groups were required to have normal nonverbal intelligence, as measured by the Kaufman Brief Intelligence Test (Kaufman & Kaufman, 1992). Scores ranged from 81 to 121, with a mean of 100.5. All subjects were required to have receptive language abilities within the average range on the *Peabody Picture Vocabulary Test* – 32 (Dunn & Dunn, 1997) (86–100, 83–115). They were also required to perform within the normal range on two expressive language tasks from the *Revised Wechsler Test of Early Communication Impairment* (Rice & Wechsler, 2001). Scores ranged from 87 to 106, with a mean of 95.23. The cut-off score for the youngest subjects was 85, which was exceeded by all subjects. Additional exclusionary criteria included being monolingual speakers of English, with English as the home language, passing a hearing screening during the current academic year, and normal oral motor structure and function established by the examiner prior to beginning testing.

Children who received free or reduced-price lunch at school were excluded by the examiner. The examiner also excluded children with any known organic, neurological, visual, motor, or frank neurological impairments. The examiner asked teachers to fill out a questionnaire to identify children who might have behavioral or social problems that could affect speech or language, which excluded them from the study.

To be included in the group of children with phonological or articulation disorders, kindergarten children with phonological or articulation disorders, without known language or hearing impairments, was referred by their school speech-language pathologists. Confirmation of their articulation- or phonological impairment was made by scores of more than one standard deviation below the mean on the *Sound-Blends*

Articulation and Phonology Evaluation (ASAFE, Bond & Hunt, 1987). Children who were referred by speech language pathologists as articulation or phonologically impaired and scored within one standard deviation of the mean were included from the study. All of the children with phonological or articulation disorders were receiving speech language services at the time the research was conducted. Normal speech production was also confirmed by obtaining a score within one standard deviation of the mean on the ASAFE.

Prior to recruiting subjects, research approval was granted from the Institutional Review Board (IRB 2) committee in the University of Florida (see Appendix A). Parents were required to complete and return a parental consent for their child to participate and a parent questionnaire outlining language development and history (see Appendix B). Teachers and speech language pathologists of the participants were required to complete and return consent forms to participate and questionnaires outlining academic performance and speech and language intervention history (see Appendix C). Child assent to participate was obtained prior to each testing session in accordance with IRB guidelines.

Procedures

The investigator conducted all research. Data collection took place in a quiet room at the children's schools. Each child was tested over three days, with an average of three 30-minute sessions required to complete testing. The total test time averaged 90 minutes per child. The children were tested between April and September of 2003. Testing for each individual child was completed over a maximum of a two-week period, and most children completed the three testing periods in a one-week period. The tests

test protocol was given Spanish participants and was presented in the same order for each child.

During the first session, two expressive grammar tasks from the *Revised MacArthur Test of Early Grammatical Development* (Rat & Wexler, 2001), the *Peabody Picture Vocabulary Test - II* (Dunn & Dunn, 1997), and the *MacArthur Inventory* from the *English Language Intelligence Test* (Kaufman & Kaufman, 1990) were administered. During the second session, the *Short Story Description and Phonology Evaluation* (Gard & Hird, 1997) and the *Mattingly-Rabin Word Naming* task were administered and videotaped. Any child who did not meet the preliminary criteria was eliminated as a participant during the first or second testing session. During the third session, the phonological awareness tasks were administered. Prompts and feedback on performance were provided uniformly to all children.

Tests Used to Qualify Subjects for Participation

Language Measures

Two standardized tests were administered to assess receptive and expressive language abilities. The *Peabody Picture Vocabulary Test - II* (Dunn & Dunn, 1997) was used to measure receptive vocabulary. This test was selected because it correlates highly (.91) with verbal ability as measured by the *Peabody Intelligence Scale for Children - Third Edition* (RBC, 90, Wexler, 1992). The maximum receptive vocabulary in children and adults. Standard assessment procedures were followed, and a standard score was obtained. Table 3-1 shows the performance of each subject in the two groups on the tests of language, nonverbal ability, and expressive phonology. Table 3-2 shows group means for each of the measures in Table 3-1.

Table 2.1. Performances on achievement measures by subject

| Subject | PPVT-III | Ross/Weber | K-BIT | SSAPB |
|---------|----------|------------|-------|-------|
| NP-1 | 104 | 98 | 123 | 74 |
| NP-2 | 108 | 94 | 83 | 75 |
| NP-3 | 122 | 100 | 121 | 83.5 |
| NP-4 | 102 | 94 | 101 | 74 |
| NP-5 | 97 | 87 | 96 | 64.5 |
| NP-6 | 123 | 100 | 104 | 75 |
| NP-7 | 103 | 97 | 102 | 64.00 |
| NP-8 | 109 | 94 | 104 | 76 |
| NP-9 | 106 | 87 | 104 | 63.5 |
| NP-10 | 110 | 100 | 96 | 64.5 |
| PL-1 | 107 | 98 | 111 | 46 |
| PL-2 | 102 | 89.5 | 88 | 34.5 |
| PL-3 | 97 | 82 | 96 | 47.5 |
| PL-4 | 94 | 94 | 102 | 37.5 |
| PL-5 | 108 | 100 | 108 | 36 |
| PL-6 | 109 | 97 | 114 | 36 |
| PL-7 | 112 | 97 | 115 | 34.5 |
| PL-8 | 106 | 96 | 115 | 37.5 |
| PL-9 | 100 | 91.5 | 107 | 37 |
| PL-10 | 112 | 95 | 112 | 30.5 |

PPVT-III=Peabody Picture Vocabulary Test-III; Ross/Weber=Screening Test from Ross/Weber Test of Early Grammatical Impairment; K-BIT= Kaufman Brief Intelligence Test; SSAPB=Short-Self Articulation and Phonology Evaluation; Percent ED=Mother's education in years

Table 2.2. Group means for achievement criteria

| | Age | PPVT-III | Ross/Weber | K-BIT | SSAPB | Percent ED |
|----------|-----|----------|------------|-------|-------|------------|
| NP Group | 6.5 | 106.1 | 94.2 | 104.5 | 68.36 | 14.6 years |
| PL Group | 6.1 | 101.1 | 94.5 | 104.5 | 34.22 | 14.3 years |

PPVT-III=Peabody Picture Vocabulary Test-III; Ross/Weber=Screening Test from Ross/Weber Test of Early Grammatical Impairment; K-BIT= Kaufman Brief Intelligence Test; SSAPB=Short-Self Articulation and Phonology Evaluation; Percent ED=Mother's education in years

The Screening Probe from the Ross/Weber Test of Early Grammatical

Impairment (Ross & Weber, 2002) was administered to assess expressive language

ability. The Screening Probe consists of two subtests that measure children's use of the

third person singular and past tense morphemes in a structured picture-naming task. The

Screening Probe was selected because kindergarten-age children usually master use of

the morphemes. Additionally, difficulty using the morphemes is characteristic of young children with specific language impairment. The *Race-Walker* test was administered on approximately 400 children between 2;6 and 6;0, half of whom had a diagnosed language disorder. The Screening Probe has a high level of sensitivity (80 or higher) for identifying children who are at risk for a language disorder, helping ensure that children likely to have a language disorder do not receive a score above the cut-off on the Screening Probe. Although a child's phonological system may make it difficult to assess whether the child uses inflectional morphemes, the *Race-Walker* test provides a phonological probe to evaluate whether production of specific sounds (final /s/, /t/ /d/ and /v/ in monomorphemic words) may impede a child's production of the grammatical morphemes tested. Standard assessment procedures were followed as outlined in the test manual, and a composite score for the two subtests was obtained. A child's score on the Screening Probe reflects the percentage of items correct. The child's score was compared to the criterion or cut-off score for each age group. None of the children in this study failed the phonological probe.

Nonverbal Ability

Nonverbal ability was assessed using the subtests subset of the *Kaufman Brief Intelligence Test* (Kaufman & Kaufman, 1990). The Matrices subtest was designed to assess nonverbal (fluid) intelligence in people from 4 to 99 years of age. The subtest measures nonverbal skills and the ability to solve new problems. A set of visual stimuli, both meaningful and abstract figures, is presented in analogy form, and the subject completes the analogy by pointing to a picture or saying the corresponding letter. The test was obtained on over 3,000 people, with more than 100 subjects at each age level.

Scoring for the Scale is based on a mean standard score of 100. For a 95% confidence level, the level of error is 4 in 12 points for 5- to 7-year-olds. The subject was administered following standard testing instructions. A standard score was obtained for each child.

Expressive Phonology

To measure phonological production ability, the *Basic Broad Articulation and Phonology Evaluation (BBAPPE: Basic & Broad, 1987)* was administered. This test evaluates production of 148 target words in response to 48 audio phon picture cards. Target words are all nouns and are designed to elicit production of initial and final complex-consonants and nasal two- and three-member clusters. Multiple exemplars of phonemes are included in the test. Unsegmented syllable production in multisyllabic words is also assessed. Phonological processes are also indicated, with a maximum of four exemplars for each process, enabling phonological analysis. The BBAPPE generates an independent analysis as well as a relational analysis with the child system, resulting in a total score. The test was normed on a national sample of more than 2000 children. A total score was obtained for each child, following standard assessment procedures. In addition to the BBAPPE, an object and picture naming task targeting multisyllabic words was used for this study. Multisyllabic words that were reported to be phonologically complex (Catts, 1984) were selected for the task. Laxness and Cain (1979) found that percent consonant-onset in multisyllabic word and non-word productions accounted for independent variance in reading achievement, whereas their standardized single word orthotopy test, the *Acoustic Articulation Proficiency Index*, did not. The multisyllabic word naming task may allow a more discrete analysis of

phonological production than the SPAPF alone, as the SPAPF relies on single word production. Lewis and Freedman (1992) found that selected phonological problems in school-age, adolescent, and adult normal speakers with a presumed history of speech and language problems could be identified through a monosyllabic word production task. Other researchers have found that processes such as weak syllable deletion, cluster reduction and assimilation or consonant insertion correlated with reading disability in earlier studies (Lewison & Catts, 1998; Majumder & Mowder, 1993). Although school-age children are not expected to persist in their use phonological processes, monosyllabic words that could potentially elicit these processes were chosen. The monosyllabic words selected for this task were *elephant, fish, five, octagon, fish, hippopotamus, refrigerator, leopard, spaghetti, microscope, demonstrator, animal, vegetable*. To elicit these words the examiner presented the subjects with pictures representing these words, and asked them to name the pictures. If a child did not know the name of an object, the examiner said the name, then asked the children name it in a delayed imitation task. After the child was familiar with the objects and target words, the task was audio recorded. If the subjects did not spontaneously produce these words, the examiner elicited the words by using a delayed imitation strategy. Percent accuracy was calculated for each monosyllabic target word. To determine accuracy of experimental production, percent consonants correct (Blensong & Kew-Youngs, 1982) was calculated for each word, and a total percent consonants correct was obtained. Phonological patterns of assimilation, substitution/consonant insertion, weak syllable deletion, and cluster reduction were also counted. Each occurrence of a pattern was assigned a score of 1. If the child did not use

a pattern, the score for the pattern production was 0. The maximum possible score was determined prior to administering the task.

The SRSPE and the Malayalam Word Naming task were recorded using a Marantz PM-101 audio-recorder. Tapes were transcribed online by the experimenter using broad transcription and were confirmed by transcribing the tapes from the audiotape at a later time. A second rater independently transcribed sections from four subjects using broad transcription (10% of total sessions). Inter-rater reliability was calculated by dividing the total number of agreements by the total number of consonants counted. Intra-rater reliability was found to be 88%.

Experimental Tasks

A battery of 18 phonological awareness tasks was administered to evaluate phonological awareness and phoneme awareness skills. The tasks were adapted from previously published works, and were selected because they were found to correlate with early reading ability (Fletcher & Bryant, 1983; Catts, 1985; MacLean, et al., 1987; Kover, 1971; Samuels et al., 1984). The tasks represent a continuum of difficulty, requiring both implicit and explicit knowledge of phonology at syllable, onset, rhyme, and phoneme levels. Tasks included clapping, identification, categorization of word final phonemes, blending, segmentation, and deletion tasks.

Syllable level tasks included syllable segmentation and syllable deletion. Syllable segmentation required subjects to count the number of syllables in stimulus words presented orally. Syllable deletion required subjects to delete a syllable from an orally presented multi-syllable word. Onset-rhyme tasks included rhyme detection and production, alliteration detection and production, initial consonant deletion, and initial

onset/blend task. Rhyme detection required children to identify rhyming words in an odd-man-out task. Alliteration detection was presented in the same odd-man-out format, requiring subjects to identify words that started with the same sound. Rhyme production required children to produce a rhyming word in response to two orally presented rhyming words. Alliteration production required subjects to produce a word beginning with the same sound as two orally presented words. The initial consonant-deletion task required children to delete the initial phoneme from a word. In the initial consonant blending task children were required to blend the initial consonant and rhyme of an orally presented word. Phoneme level tasks included blending CVC words and final consonant categorization. In the CVC blending task, children blended three orally presented phonemes to say the target word. Final consonant categorization required children to identify which of four words did not share a common final consonant sound.

Tasks were presented in the following order: rhyme detection and production, alliteration detection and production, syllable deletion, initial consonant deletion, blending onset consonant and rhyme, blending CVC words, syllable segmentation, and final consonant categorization. Scores were calculated for each task by adding the number of correct responses for each task. The maximum score on each task was 10. To ensure the children understood each task, two or three practice trials were presented with corrective feedback before administering the experimental trials. If a child provided an incorrect response during the practice trials, the examiner told the child the correct answer and explained why the child's answer was incorrect. The children were told to try their best and that if they did not know an answer they should guess. Descriptions of the

tasks are included below. Dend Clip Art was used to create the set for picture-phoneme tasks that used pictures.

Raynes Discrimination

This task measures a child's ability to identify rhyming words. It is based on a rhyme task proposed by MacLean et al. (1987). Children were presented with four words and were shown a picture plus word for each corresponding picture. Subjects were asked to identify which word did not rhyme with the other three words. Based on suggestions of hierarchical difficulty (Ball, 1993; Level & Carter, 1981) five sets constituted a foil that contained non-phonemes in common with the rhyming words, and five items had a foil that contained two phonemes in common with the rhyming words. The consistent read, "We're going to talk about some rhyming words. Do you know what rhyming words are? If I say 'hey, hey' those words rhyme, they sound the same. Like hit, kit, we words that rhyme too. Now I am going to say four words, and one of them does not rhyme with the other three. Your job is to tell me which word does not rhyme with the other three. Let's try." Pictures corresponding to correct response items were presented in different positions. Two trials were presented before beginning the 10 iterations across stimulus items are shown in Table 2.9 below.

Table 2.9. Raynes discrimination task stimuli

| T1 cat bat mat pat | T2 dog bag mag pig |
|--------------------|--------------------|
| 1 bat bat cat bag | 6 cat rat hat cot |
| 2 cat bat mat mag | 7 rat fat mat map |
| 3 rat bat fat bat | 8 cat bat map fat |
| 4 bag rat bag bat | 9 mag bag rat bag |
| 5 pig map bag cat | 10 cat map pig bat |

Rhyme Production

This task measures a child's ability to produce a rhyming word in response to two rhyming words. It was adapted from MacLean et al. (1997). Children were asked to say a word that rhymed with two words presented orally by the examiner. Subjects were instructed as follows: "There is a game that we will use to tell you a rhyming word. I'm going to say two words to you, and you tell me another word that rhymes with my words. Let's try it out. If I say *bat*, *cat*, can you think of another word that rhymes with those?" If the child responded correctly, then a second trial was presented. If the child did not respond correctly, then the examiner presented the items again and said, "Hoi, cat, those words end in the sound /k/. Can you think of another word that ends that way? How about *pat*?" The examiner then moved on to the second trial also providing corrective feedback if necessary before beginning the ten stimulus items. Real and nonsense words were accepted as correct responses. Stimulus items are shown in Table 2-4.

Table 2-4. Rhyme production task words

| T1: bat, cat, _____ | T2: cat, bat, _____ |
|----------------------|---------------------|
| 1. cat, bat, _____ | 6. tea, shoe, _____ |
| 2. top, hop, _____ | 7. sea, sea, _____ |
| 3. cat, fat, _____ | 8. cup, sky, _____ |
| 4. moon, soon, _____ | 9. pin, when, _____ |
| 5. fox, box, _____ | 10. cup, cup, _____ |

Aliteration Detection

This task measures a child's ability to identify words that begin with the same initial consonant. It is based on Goodlay and Bryant (1985). As in the rhyme identification task, children were presented with four words and four pictures. The examiner said, "We're going to talk about words that start with the same sound. I'm going to say four words to you, and you job is to tell me which word starts with a

different sound. * Children were shown picture plates with four pictures on each plate representing words that the examiner said to the child. Three of the words shared the same initial consonant, but the fourth word did not. Children were asked to identify the word that started with a different sound from the other three. The subject was told whether he was correct or incorrect and why before the remaining picture trials and experimental trials were completed. Two picture items that are test items were administered. Test items consisted of three voiceless stops, three voiced stops, three fricatives, and two nasal consonants. Stimuli are shown in Table 2-1 below.

Table 2-1. *Alternative detection task stimuli*

| T1. <u>dog dog don't see</u> | T2. <u>tea tea tea tea</u> |
|------------------------------|----------------------------|
| 1. pig pig pig pig | 6. tea tea tea tea |
| 2. say say cat cat | 7. foot foot foot see |
| 3. tea tea tea dog | 8. cat cat cat cat |
| 4. say cat cat cat | 9. tea tea cat cat |
| 5. dog dog cat pig | 10. tea tea tea tea |

Alternative Production

This task measures a child's ability to produce a word that begins with the same initial consonant as two models (MacLean et al., 1987). As in the rhyme production task, the child is asked to say a word that begins with the same initial sound as two words presented by the examiner. No visual stimuli were used for this task. Subjects were told "You going to say two words that start the same, and I want you to tell me another word that begins the same way. Let's try it out. *Man moon, lion words both start with /m/*. Can you tell me another word that starts with the same sound?" If the children were not able to generate an alternative response they were told why their answer was incorrect, and the examiner modeled a correct response before moving on to the second picture item. Test items consisted of three voiceless stops, three voiced stops, three voiceless

insurers, and one nasal consonant. Real and nonsense words were assigned as stimuli responses. Stimuli are shown in Table 3.6.

Table 3.6. Alliteration production task stimuli

| T1 | mean: monkey (monkeys) | T2 | key: key |
|----|------------------------|----|--------------|
| 1 | top: top | 6 | go: go |
| 2 | pat: pat | 7 | boat: boat |
| 3 | cat: cat | 8 | see: see |
| 4 | bat: bat | 9 | short: short |
| 5 | dog: dog | 10 | man: man |

Syllable Deletion

This task measures a child's ability to segment a word by deleting one of the syllables (Catts, 1993; Brown, 1971; Smith & Catts, 1994). The examiner said a day/late or monkey/late word, such as *broccoli*, then asked the children to say the word again without saying a designated syllable or syllables (e.g., "Say it again, but don't say *bro*"). Subjects were presented with two practice words and ten experimental words to segment. Practice items were *cupcake* (*broccoli*). Stimuli for this task are shown in Table 3.7.

Table 3.7. Syllable deletion task stimuli

| | |
|-----------|----------|
| Ladder | golfball |
| Secretary | keychain |
| Error | owl-owl |
| Computer | baking |
| Barn | mangle |

Initial Consonant Deletion

This task measures a child's ability to segment a word by deleting the initial consonant (Stavrouli et al., 1994). Children were presented with a CNC word such as "cat" and told to repeat the word, then say it again without the initial sound. During the practice items, the examiner said, "Say cat. Now strip off the first sound and tell me

what word is left?" Two picture items, cat and cow were presented, and children were told whether their response was correct or not and why. If children struggled to perform similar tasks, such as denying or affirmations, the examiner said: "What is the first sound?" Here take a cat and tell me what kind word is left." If children were not able to identify the first sound of the picture items, the examiner provided the sound, they continued through the prompts. All words contained real words when the initial sound was deleted. Test items consisted of three nonsense stops, two nonsense stops, and four nonsense fricatives. Stimuli for this task are shown in Table 2.8

Table 2.8. Initial consonant deletion task stimuli

| | |
|-----|-----|
| pat | bat |
| bit | fat |
| pid | pid |
| bat | bat |
| bat | bat |

Initial Consonant – Rhyme Matching

This task measures the ability to blend words to form a word at the level of the onset-rhyme. It was adapted from Carter's (1974) task. The examiner showed the subject a puppet and said, "This puppet has a tough time talking. He says words one part at a time. He wants you to listen and say the words the right way. He will say 't' (onset) and you would say 'art' Let's try it." Two picture items (cat and cow) were presented before moving to the test item boxes. The subject was told whether his response was correct, and feedback was provided before moving to the next picture item. Children were presented with five words beginning with consonant sounds and five words beginning with stop consonants. Vowel and nonsense stops and nonsense fricatives and nasal consonants were included in the task. Stimuli for this task are shown in Table 2.9

Table 2-8. Initial consonant – rhyme blending task (4/7/93)

| | |
|-----|------|
| p-m | map |
| m-m | man |
| f-h | path |
| s-p | spat |
| t-l | lat |

Consonant-Vowel Consonant Word Blending

This task was also adapted from Catts' (1993) Blending task. It measures the ability to blend onset phonemes to form a word. The examiner showed the subject another puppet and said, "This puppet has to read together how saying his words. He says the parts of words, and you join them together all together to say the words for him. So if he says /t/ /a/ /p/, you would say 'tap'." Children were presented with two practice items, tick and map, and given extensive feedback before beginning experimental items. They were presented with 18 words one phoneme at a time. They were given five words beginning with /t/ and five words beginning with /m/ and three words beginning with /p/. Sample for this task are shown at table 2-10.

Table 2-10. CVC Blending task words

| | |
|-----------|-------|
| t-a-p | t-u-n |
| k-i-c-k | k-i-n |
| d-r-u-n-k | s-u-n |
| p-a-t | h-a-p |
| t-a-p | h-u-n |

Syllable Segmentation

This task measures a child's ability to identify the number of syllables in a word by clapping or counting the number of syllables in two words containing one, two, or three syllables (Lieberman et al., 1974). The examiner tapped out the number of beats in three words with one, two and three syllables, and then asked the child to tap out the syllables in those real words. If the child showed difficulty with the task, the examiner

choose another nonsyllabic word from the environment, such as *room* or *wall* to slip out, and also asked the child to slip out another own name. Trial words were *computer*, *happy* and *tail*. Continuous feedback was provided. Stimuli for this task are shown in Table 2.

11

Table 2-11. Syllabic segmentation task stimuli

| | |
|----------|------------|
| odd | money |
| fox | chimpanzee |
| head | crust |
| particle | alligator |
| balloon | crustifier |

Final Consonant Categorization

This task measures a child's ability to identify the final sounds in CVC words. It was adapted from Bryant et al. (1981). Subjects were instructed to identify the word that ended with a different sound than the other three words. Instructions followed the rhyme categorization task. The experimenter said to the child, "We're going to say four words but one of the words ends with a sound that is different from the other words. Like this. If I say 'cat, hat, cat, pop,' the word that ends with a different sound is pop. Now you try it. Which word ends with a sound that is different from the other words: street, lion, cat, hat?" The child was told whether his response was correct or not and why (e.g., "That's lion, lion, cat, hat, the word that has a different ending sound is cat. Cat ends with a /t/ sound, and the other words all end in /t/." Cat you hear (/t/)). The responses generated in the second position class, using the words *cat, lion, dog, wife*. Stimuli for this task are shown in Table 2-12.

Table 3-12. Word component correspondence task results

| T1 | mean, <i>sd</i> , <i>rd</i> , <i>leg</i> | T2 | mean, <i>sd</i> , <i>rd</i> , <i>leg</i> , <i>gate</i> |
|----|--|----|--|
| 1 | watch, watch, watch, watch | 4 | hall, hall, pull, hall |
| 2 | top, top, top, top | 7 | bag, bag, bag, bag |
| 3 | cat, cat, hat, leg | 8 | hat, hat, hat, hat |
| 4 | back, back, back, back | 9 | hat, hat, hat, watch |
| 5 | leg, door, mouse, hat | 10 | bag, bag, top, bag |

CHAPTER 5 RESULTS

The purpose of this study was to determine whether a) children with phonological impairments differ from children without phonological impairments on a group of phonological awareness tasks, b) specific phonological error patterns correlate with composite phonological awareness ability, c) specific phonological error patterns correlate with phonological awareness ability at specific levels, and d) children with and without phonological impairments find syllable level tasks easier and phoneme-level tasks more difficult. A paired samples t-test was used to determine whether group-means differed for each group on total phonological awareness when the variable of classroom was used to match pairs of subjects. A paired samples t-test was also used for each of the 10 phonological awareness subtests. Regression analysis was used, and Pearson correlation coefficients were calculated to assess the strength of the relationship between phonological error patterns and total phonological awareness and between general phonology awareness and individual phonological awareness tasks. One-way ANOVA and Scheffé's post hoc tests were used to determine which of the phonological awareness subtests were more difficult than others. Significance levels were set at .05.

Group Comparisons of Phonological Awareness Tasks

The goal of these analyses was to determine whether differences exist between groups on a total phonological awareness score and on individual phonological awareness scores. The phonological awareness subtests were 1) rhyme detection, 2) rhyme

production, 3) alternation deletion, 4) alternants production, 5) syllable reorganization, 6) initial consonant blending, 7) CVC blending, 8) syllable deletion, 9) initial consonant deletion, and 10) final consonant reorganization. The maximum score for each of the 18 subtests was 30, and the total phonological awareness score was 180.

The mean total phonological awareness score for the NP group was 80.4 ($SD=12.17$) and for the PI group, the total mean score was 68.4 ($SD=12.68$) (Table 3-1). Subject scores assigned for matched pairs are shown for each task in table 3-2.

Table 3-1. Mean scores for total phonological awareness by group.

| | | Std. | | | |
|--------|-------|---------|----|-----------|-----------------|
| | | Mean | N | Deviation | Std. Error Mean |
| Pair 1 | TOTAL | 80.4000 | 30 | 12.17574 | 4.36653 |
| | Pa. | | | | |
| Pair 2 | TOTAL | 68.4000 | 30 | 12.65885 | 3.94594 |
| | Pa. | | | | |

Table 3-2 shows pair-matched scores for both the total phonological awareness score and for individual phonological awareness tasks. Across all subjects, total phonological awareness scores ranged from 45-95. Total phonological awareness score for the paired samples show that children in the NP group always had higher total phonological awareness scores than the children with PI from the same classroom. In all but one of the classroom subjects in the NP group performed better than subjects in the PI group, and in the remaining classroom phonological awareness scores for the NP and PI subjects were equal. In none of the classrooms PI subjects performed better than both NP and PI subjects from other classrooms. There was no classroom in which children with PI performed better in any of the phonological awareness subtests or total phonological awareness score than the children in the NP group.

Table 3.2. Total phonological awareness and subskill means for all subjects

| | Total Pa | AD | AP | AD | AP | Syll S | IC-D | CVC-D | Int-D | IC-D | PC- C |
|------|-------------|----|----|----|----|-----------|------|-------|-------|------|----------|
| NP1 | 36 | 3 | 9 | 8 | 18 | 8 | 10 | 10 | 9 | 10 | 3 |
| PL | 36 | 8 | 10 | 9 | 18 | 9 | 10 | 9 | 8 | 10 | 3 |
| NP2 | 32 | 3 | 3 | 1 | 4 | 6 | 10 | 10 | 7 | 6 | 3 |
| PL | 42 | 5 | 1 | 3 | 9 | 8 | 8 | 8 | 8 | 9 | 3 |
| NP3 | 66 | 8 | 18 | 9 | 18 | 18 | 18 | 9 | 8 | 20 | 8 |
| PL | 59 | 10 | 18 | 8 | 18 | 7 | 18 | 18 | 9 | 10 | 6 |
| NP4 | 42 | 5 | 18 | 18 | 18 | 3 | 18 | 18 | 18 | 9 | 5 |
| PL | 60 | 3 | 8 | 8 | 10 | 4 | 18 | 18 | 8 | 9 | 3 |
| NP5 | 18 | 3 | 8 | 8 | 10 | 8 | 18 | 18 | 9 | 8 | 6 |
| PL | 64 | 6 | 4 | 8 | 9 | 8 | 18 | 10 | 8 | 8 | 3 |
| NP6 | 84 | 8 | 18 | 9 | 9 | 3 | 18 | 10 | 10 | 18 | 8 |
| PL | 62 | 8 | 8 | 3 | 9 | 8 | 18 | 8 | 8 | 1 | 3 |
| NP7 | 93 | 8 | 18 | 18 | 8 | 18 | 18 | 18 | 9 | 18 | 7 |
| PL | 88 | 7 | 18 | 8 | 18 | 7 | 18 | 20 | 8 | 8 | 6 |
| NP8 | 87 | 8 | 18 | 7 | 18 | 18 | 18 | 9 | 18 | 18 | 7 |
| PL | 78 | 9 | 3 | 9 | 9 | 6 | 18 | 10 | 10 | 8 | 8 |
| NP9 | 79 | 8 | 18 | 8 | 8 | 1 | 9 | 18 | 8 | 9 | 8 |
| PL | 72 | 8 | 18 | 18 | 8 | 3 | 9 | 8 | 3 | 8 | 8 |
| NP10 | 68 | 2 | 8 | 8 | 18 | 8 | 18 | 8 | 8 | 8 | 3 |
| PL | 60 | 2 | 8 | 6 | 18 | 7 | 9 | 8 | 8 | 6 | 3 |

NP=Phonological Awareness; AD=Onset Deletion; AP=Rhyme Production;

AD=Attention Deletion; Syll-S=Syllable Segmentation; IC-D=Initial Consonant Deletion; Int-D=Syllable Deletion; IC-D=Initial Consonant Deletion; PC-C=Final Consonant Concatenation.

Results of the study reveal that total phonological awareness scores were significantly different for the two groups ($p < .001$; Table 3-4). This finding is also relatively significant because it has a large effect size ($d = .82$). Classical significance refers to the power associated with a test, which is the probability of rejecting the null hypothesis when it is false. Power is related to sample size and study

designs, and high power results in large critical effect sizes, meaning that the test can effectively reject the false null hypothesis.

Table 3-3 Descriptive statistics for physiological response tests

| | Group | Mean | Std. Deviation | Range |
|---------------------|-------|------|----------------|-------|
| Total Physiological | NF | 80.4 | 17.77 | 52-98 |
| Arousal | F1 | 71.5 | 14.52 | 40-85 |
| Escape | NF | 60 | 2.74 | 28-90 |
| Defensive | F1 | 59 | 2.95 | 28-90 |
| Escape | NF | 59 | 1.95 | 58-90 |
| Production | F1 | 63 | 3.06 | 0-90 |
| Allegation | NF | 79 | 2.48 | 18-90 |
| Defensive | F1 | 73 | 2.22 | 58-90 |
| Allegation | NF | 80 | 1.88 | 48-90 |
| Production | F1 | 86 | 2.22 | 58-90 |
| Syllable | NF | 66 | 3.08 | 28-90 |
| Segmentation | F1 | 38 | 1.81 | 30-90 |
| Initial Consonant | NF | 89 | 11 | 88-90 |
| Blending | F1 | 88 | 88 | 88-90 |
| CVC | NF | 87 | 48 | 88-90 |
| Blending | F1 | 89 | 1.88 | 88-90 |
| Syllable | NF | 83 | 3.13 | 78-90 |
| Defensive | F1 | 81 | 3.26 | 58-90 |
| Initial Consonant | NF | 83 | 3.15 | 88-90 |
| Defensive | F1 | 83 | 3.35 | 88-90 |
| Final Consonant | NF | 93 | 2.75 | 18-90 |
| Categorization | F1 | 47 | 2.38 | 18-50 |

Table 3-4 Paired samples t-test for group differences for total physiological responses

| | Mean | Std. Deviation | Std. Error Mean | t | df | Sig. (2-tailed) |
|-------------------------------|-------|----------------|-----------------|-----|----|-----------------|
| For 1: TOL-ALFA- TOL-ALFA2 | 12.00 | 9.38 | 4.07 | 2.9 | 9 | .021 |

Only one of the subjects, subject production, was significantly different for the two groups in paired samples t-test ($p = .005$, Table 3-5). Significant levels were adjusted using a Bonferroni correction ($p = .004$) to account for the 11 t tests used in this subsection.

Table 3.5. Paired sample t-test for phonological awareness subtests

| | | Mean | SD | | t | df | Sig. (2-tailed) |
|---------|-----------------------|-------|-----------|---------|------|----|-----------------|
| | | | (Between) | (Error) | | | |
| Pair 1 | TOTALPA- TOTALPA2 | 12.00 | 5.30 | 2.94 | 4.07 | 9 | .008 |
| Pair 2 | REYDET - REYDET2 | .50 | 2.87 | .92 | .33 | 9 | .746 |
| Pair 3 | REYPROD - REYPROD2 | 2.90 | 2.72 | .86 | 2.26 | 9 | .048 |
| Pair 4 | ALLDET - ALLDET2 | .90 | 2.24 | 1.06 | .64 | 9 | .432 |
| Pair 5 | ALLPROD - ALLPROD2 | .30 | 1.08 | .34 | 1.46 | 9 | .177 |
| Pair 6 | SYLSEG - SYLSEG2 | .90 | 2.72 | .86 | 1.04 | 9 | .318 |
| Pair 7 | ICLEND - ICLEND2 | .30 | .87 | .21 | 1.40 | 9 | .189 |
| Pair 8 | CVCLEN - CVCLEN2 | 1.00 | 1.69 | .53 | 1.85 | 9 | .096 |
| Pair 9 | SYLDEL - SYLDEL2 | .80 | 1.21 | .48 | 1.92 | 9 | .087 |
| Pair 10 | ICDEL - ICDEL2 | 2.90 | 4.93 | 1.48 | 2.01 | 9 | .075 |
| Pair 11 | CCCAT - CCCAT2 | 1.20 | 2.44 | 1.15 | 1.04 | 9 | .325 |

TOTALPA=Total Phonological Awareness, REYDET=Rhyme Detection,

ALLDET=Alliteration Detection, ALLPROD=Alliteration Production,

SYLSEG=Syllable Segmentation, ICLEND=Initial Consonant Blending,

CVCLEN=CVC Blending, SYLDEL=Syllable Deletion, ICDEL=Initial Consonant

Deletion, CCCAT=Final Consonant-Correspondence

Initially, an independent samples t-test was used to determine whether the two groups performed differently on the phonological awareness tasks. Just levels of significance were not achieved. Power was also very weak for the test, at a level of 0.181, indicating an 81% chance of failing to detect a false null hypothesis. However, the fact that NP and P1 subjects were matched by a classroom teacher allowed for a paired samples t-test to be used to test for group differences. Also, support for concluding that test scores from the results of a two-way ANOVA that compared total

phonological awareness scores between subjects by classroom and showed significant differences for pairs of subjects between classrooms ($p < .001$, Table 3a). The difference between classrooms was also classically significant because the effect size for the finding was large ($\eta^2 = .84$).

Table 3a. One-way ANOVA results for total phonological awareness scores by classroom.

| | Sum of Squares | df | Mean Square | F | Significance Level |
|----------------|----------------|----|-------------|-------|--------------------|
| Between Groups | 5233.250 | 9 | 581.461 | 5.950 | .000 |
| Within Groups | 408.900 | 10 | 40.890 | | |
| Total | 5642.150 | 19 | | | |

Results of the paired samples *t* test for total phonological awareness indicated that children in the NP group always had higher total phonological awareness scores than the children with PI from the same classroom. In all but one of the classrooms, subjects in the NP group performed better than subjects in the PI group, and in the remaining classroom, phonological awareness scores for the NP and PI subjects were equal. In some of the classrooms, PI subjects performed better than both NP and PI subjects from other classrooms. There was no classroom in which children with PI performed better on any of the phonological awareness subtests or total phonological awareness score than the children in the NP group.

Relationship of Phonology to Total Phonological Awareness

The goal of these analyses was to determine whether phonological production could account for the variance in total phonological awareness scores. A linear regression analysis was used to determine whether any of the independent variables that measured phonological production (SHAPE, Nuclei_FOC, Total Phonemes, Weak Syllable Deletion, Assimilation, Consonant Cluster Reduction, and Misarticulation) contributed to the

total phonological awareness score (Table 3-7). None of the independent phonological production variables made significant contributions beyond other independent variables.

Table 3-7. Linear regression for phonological production variables to total phonological awareness.

| Model | | Unstandardized Coefficients | | Standardized Coefficients Beta | t | Sig. |
|-------|------------|-----------------------------|------------|--------------------------------|------|------|
| | | B | Std. Error | | | |
| 1. | (Constant) | 66.56 | 61.25 | | 1.09 | .287 |
| | MULTIPOC | -.32 | .87 | -.28 | -.37 | .714 |
| | WCVLDEL | 1.84 | 7.11 | .19 | .27 | .789 |
| | ASSEMCL | -.43 | 4.40 | -.08 | -.10 | .920 |
| | CLSTRRED | -.80 | 4.80 | -.07 | -.14 | .879 |
| | METATRED | 2.81 | 3.88 | .36 | .91 | .379 |
| | SHAPE | .21 | .70 | .24 | .31 | .614 |

a. Dependent Variable: TOTALPA

MULTIPOC=History/Initial Percent Consonants Correct, WCVLDEL=Weak Syllable Deletion, ASSEMCL=Assimilation, CLSTRRED=Cluster Reduction, METATRED=Metathesis, SHAPE=Short-Front Articulation and Phonology Evaluation.

Pearson Correlation Coefficients were calculated to measure the strength of the relationships between total phonological awareness and each of the independent variables that measured phonological production (Table 3-8). Correlations were significant at $p < .05$ for four of the production variables: (1) MultipoC, (2) Total Processes, (3) Metathesis, and (4) Shape. Metathesis correlated negatively with total phonological awareness ($r = -.488$, $p < .01$). Use of metathesis decreased as phonological awareness increased. MultipoC correlated positively with total phonological awareness ($r = .61$, $p < .01$), and total processes correlated negatively with phonological awareness ($r = -.42$, $p < .05$). As total phonological awareness increased, MultipoC scores increased and use of all processes (assimilation, weak syllable deletion, cluster reduction, and metathesis) decreased.

Table 2.8 Pearson correlation coefficients for total physiological measures and physiological production measures

| | TOTL PA | MLLT PCC | PRDC TOTL | WK SYL DEL | ASSM | CLST BECN | MET | SLAPH |
|----------------|------------|-------------|--------------|------------------|------|--------------|------|-------|
| TOTAL PA | 1.000 | .41 | .45 | -.25 | .11 | -.18 | -.40 | .32 |
| Age (1-100) | | .03 | .02 | .18 | .21 | .04 | .01 | .01 |

TOTL PA=Total Physiological Assessment; MLLT/PCC=Memory/Color Pattern Comparison Control; PRDC TOTL=Total Processing; WK SYL DEL=Word Syllable Deletion; ASSM=Assimilation; CLST BECN=Cluster Reduction; MET=Metathesis; SLAPH=Short-Rated Articulation and Phonology Evaluation

Relationship of Phonology to Specific Physiological Assessment Tasks

The goal of this analysis was to determine the strength of the relationship between physiological production and individual physiological assessment tasks (Table 2.8). Total processing correlated negatively with rhyme production ($r = .03$), initial consonant blending ($r = .12$), and CVC blending ($r = .40$). Morph-PCC correlated positively with rhyme production ($r = .40$), initial consonant blending ($r = .37$), and CVC blending ($r = .47$). Consonant onset-R reduction correlated negatively with rhyme production ($r = .30$) and metathesis correlated negatively with rhyme production ($r = .42$), assimilation production ($r = .37$), initial consonant blending ($r = .04$), and CVC blending ($r = .30$). Word syllable deletion and assimilation did not correlate with any of the physiological assessment tasks. Metathesis had a stronger relationship with the individual physiological assessment tasks than any other of the physiological production variables.

Comparisons within Physiological Assessment Tasks

The goal of this analysis was to determine whether any of the 18 physiological assessment subtests were significantly different from the other tests. A one-way ANOVA

with an adjusted alpha of $p = .005$ was used to determine differences among subjects (Table 3-40). The one-way ANOVA indicated significant differences between individual phonological awareness tasks ($F=8.601, p<.001$).

Table 3-10. One-way ANOVA's for differences between phonological awareness subtests

| | Sum of Squares | DF | Mean Square | F | Sig. |
|----------------|----------------|-----|-------------|-------|------|
| Between Groups | 421.788 | 8 | 52.724 | 8.601 | .000 |
| Within Groups | 1044.638 | 170 | 6.145 | | |
| Total | 1470.388 | 180 | | | |

Post hoc analysis using Scheffé's test indicated that only some of the subjects mean scores were significantly different from one another (see Table 3-11 for total mean scores). Rhyme production, alliteration detection, and initial consonant deletion were not significantly different from any of the other subjects. Rhyme detection was significantly different (more difficult) than initial consonant blending ($p=.003$). Initial consonant blending was significantly easier than rhyme detection ($p=.003$). Syllable segmentation ($p=.004$) and final consonant segmentation ($p=.001$). CVC blending was significantly easier than final consonant segmentation ($p=.001$). Final consonant segmentation was significantly more difficult than alliteration production ($p=.004$), initial consonant blending ($p=.004$), and CVC blending ($p=.004$).

Pearson correlation coefficients were calculated to determine the strength of the relationship among the total phonological awareness mean and the 10 phonological awareness subtests (Table 3-12). The alpha level of $p=.05$ was adjusted using a Bonferroni correction to $p=.005$. Of the ten subtests, eight were found to correlate significantly with total phonological awareness: rhyme detection, rhyme production,

alternation deletion, alternation production, initial consonant blending, CVC blending, onset consonant deletion, and final consonant compensation. Two of the subtests did not correlate with the total phonological awareness score: syllable segmentation and syllable deletion. Further, the syllable tasks did not significantly correlate with each other.

Initial consonant deletion correlated most highly with total phonological awareness ($r = .73$). Several of the tasks correlated with each other, but syllable deletion and syllable segmentation did not correlate significantly with any of the other tasks.

Table 3.14. Mean scores and ranges for phonological awareness subtests for all subjects

| Phonological Awareness Subtest | N | Mean | Minimum | Maximum |
|--------------------------------|----|------|---------|---------|
| Initial Consonant Blending | 20 | 9.35 | 6.00 | 10.00 |
| CVC Blending | 20 | 9.30 | 6.00 | 10.00 |
| Alternation Production | 20 | 8.80 | 6.00 | 10.00 |
| Syllable Deletion | 20 | 8.45 | 6.00 | 10.00 |
| Alternation Deletion | 20 | 7.70 | 6.00 | 10.00 |
| Rhyme Production | 20 | 7.55 | 6.00 | 10.00 |
| Initial Consonant Deletion | 20 | 7.20 | 6.00 | 10.00 |
| Syllable Segmentation | 20 | 6.70 | 2.00 | 10.00 |
| Rhyme Deletion | 20 | 5.95 | 2.00 | 10.00 |
| Final-Consonant Compensation | 20 | 5.60 | 1.00 | 9.00 |

Group Comparisons within Phonological Production Tasks

The goal of this analysis was to determine whether the two groups performed differently on the independent variables of phonological production: Multi-PCC, Total Phonics, Word Syllable Deletion, Alternations, Cluster Reduction, and Substitutions. Paired samples *t*-tests were used to compare group performance on the phonology measures derived from the multi-syllable word naming task (Table 3.14). A Bonferroni correction was used to adjust the alpha level for the multiple *t*-tests to $p < .005$. At this level of significance, only Multi-PCC scores were different for the two groups.

Table 3-13: Paired samples *t*-tests for Multi-PCC, Total Processes, Weak Syllable Deletion, Assimilation, Cluster Reduction and Metathesis

| | | Mean | Std Deviation | Std Error Mean | <i>t</i> | df | Sig. (bilateral) |
|------|-----------|-------|------------------|----------------------|----------|----|---------------------|
| Pair | MULTPCC1 | 18.40 | 11.43 | 3.87 | 3.14 | 9 | .004 |
| 1 | MULTPCC2 | | | | | | |
| Pair | TOTPRCC1 | -4.00 | 4.05 | 1.26 | -3.11 | 9 | .012 |
| 2 | TOTPRCC2 | | | | | | |
| Pair | WSYLDL1 - | -.00 | .96 | .30 | -1.66 | 9 | .081 |
| 3 | WSYLDL2 | | | | | | |
| Pair | ASSIM1 - | 1.00 | 1.48 | .47 | 2.12 | 9 | .043 |
| 4 | ASSIM2 | | | | | | |
| Pair | CLUSTRD1 | -1.00 | 1.73 | .54 | -1.58 | 9 | .079 |
| 5 | CLUSTRD2 | | | | | | |
| Pair | METATR1 - | 1.20 | 1.82 | .57 | 2.24 | 9 | .021 |
| 6 | METATR2 | | | | | | |

MULTPCC=Many-Syllable Word Percent Correctness Corpus, TOTPRCC=Total Phonological Processes, WSYLDL=Weak Syllable Deletion, ASSIM=Assimilation, CLUSTRD=Cluster Reduction, METATR=Metathesis

Partial Correlation Coefficients were used to determine which of the phonological production measures correlated with oral motor (Table 3-14). The Multi-PCC measure was significantly and strongly correlated with the oral motor on the SIKAPB ($r=.33$). It was also significantly negatively correlated with weak syllable deletion ($r=-.48$), cluster reduction ($r=-.31$), and metathesis ($r=-.31$). As Multi-PCC increased, use of those processes decreased. Total-processes were correlated significantly and negatively with the SIKAPB score ($r=-.49$) and with the Multi-PCC measure ($r=-.89$).

Effects of Independent Variables on Group Performance

The goal of this analysis was to determine whether the independent variables used to select subjects for this study were related to their total phonological measures scores. Regression analysis revealed that none of the independent variables (age, non-verbal

ability, receptive language, and expressive language) correlated significantly with the total phonological awareness score (Table 3-13).

Table 3-14. Correlations (bivariate) among independent variables that measure phonological production

| | PIRA TOTL | MULT PCC | WVGT DEL | ADDDEL | CLST RIDD | METL TOSL | SHLFTL |
|-----------|--------------|-------------|-------------|--------|--------------|--------------|--------|
| PIRA TOTL | - | .39** | .29** | .49* | .33** | .35** | .48** |
| MULT PCC | | - | -.38** | .44 | .13** | -.11** | .23** |
| WVGT DEL | | | - | .13 | .32** | .49* | .22* |
| ADDDEL | | | | - | .37 | .26 | .49** |
| CLST RIDD | | | | | - | .72** | .49* |
| METL TOSL | | | | | | - | .37** |
| SHLFTL | | | | | | | - |

** Correlation is significant at 0.01 (2-tailed). * Correlation is significant at 0.05 (2-tailed).

Table 3-15. Regression analysis for independent variables

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|------------|-----------------------------|------------|---------------------------|-------|------|
| | B | Std. Error | | | |
| (Constant) | -142.288 | 73.800 | | 2.308 | .043 |
| AGE | 1.793 | .930 | .404 | 1.958 | .073 |
| IQBT | .670 | .400 | .463 | 1.775 | .104 |
| PPVT | -.003 | .448 | -.004 | -.812 | .430 |
| RECEIVED | .936 | 1.602 | .265 | .574 | .547 |
| PARLITED | -1.213 | 1.332 | -.175 | -.405 | .684 |

a. Dependent Variable: TOTALPA

IQBT= Kaufman Brief Intelligence Test, PPVT=Peabody Picture Vocabulary Test- III
RECEIVED=Screening Test of Receptive/Expressive Test of Early Grammatical Impairment,
PARLITED=Mother's education level in years

Parent education level has been found to correlate significantly with phonological awareness ability of young children (Coker, Fay, Tomblin & Chao, 2002). It may also represent some of the differences that exist between schools (educational), such as level of literacy exposure to the home and SES. To determine whether parent education could account for the variability between the NP and PL groups, linear regression analysis was conducted. Mother's level of education did not contribute to total phonological awareness score more than any of the other independent variables of age, nonverbal IQ,

receptive language, or expressive language. A Pearson correlation coefficient was calculated to determine whether mother's education level correlated with total phonological awareness ($r = .023$, but it was not statistically significant (Table 2.14). Age ($r = .553$) and expressive language score ($r = .834$) correlated significantly with total phonological awareness scores with a large effect size.

Table 2.14 Correlation coefficients and significance levels for total phonological awareness and subphonological variables

| | TOTAL PA | SEG.PE | AGE | PARMTECH | REPT | EXP.T | RE.T |
|------------------------|-------------|--------|------|----------|------|-------|------|
| TOTALPA | 1.000 | .36 | .33 | -.02 | .64 | .27 | .32 |
| Pearson Coefficient | | | | | | | |
| Significance Level | | .011 | .008 | .468 | .024 | .140 | .008 |

Summary of Results

Significant differences in total phonological awareness scores were found

between subjects when the variable of classroom was used to match the pairs of MP and PI subjects. Significance level ($p < .001$) and large effect size (.71) indicate that the finding has both statistical and practical significance. A one-way ANOVA comparing total phonological awareness scores between classes confirmed the finding that MP and PI classes were different from class to class.

For the phonological awareness variables, the only phonological awareness task to differ between MP and PI subjects was the task of rhyme production when the two groups were compared for mean performance. The MP group mean for the task was 8.9 ($SD = 1.87$) and the mean for the PI group was 8.2 ($SD = 1.98$). Many of the tasks correlated strongly with each other and with the total phonological awareness score. However, the two syllable level tasks syllable representation and syllable deletion, did not

correlated with total phonological awareness with each other or with the other subtests. Initial consonant deletion correlated highest with total phonological awareness ($r = .837$), followed by rhyme production ($r = .766$).

Regression analysis on the phonological production variables was used to determine whether the independent variables that measure phonological production contributed to the total phonological awareness score. Most of the independent variables used to measure phonology accounted for variance in the total phonological awareness score beyond the contributions made by the other (two independent variables used in the model).

The NP and PI groups did not share the same ranking of phonological awareness task difficulty, but the three easiest tasks and the single most difficult task were the same for both groups. Nonsense group named highest on syllable-level tasks. Phoneme-level tasks included CVC blending and Final Consonant Categorization. CVC blending was the second easiest task for both groups, and final consonant categorization was the most difficult task for both groups.

Regression analysis indicated that some of the independent variables (age, nonverbal IQ, receptive language, expressive language, and parent education) could account for variability in total phonological awareness at significant levels. A one-way ANOVA and post hoc analysis using Scheffé's test showed that most of the phonological awareness subtests were significantly easier than others. Rhyme detection was more difficult than nonsense blending, and final consonant categorization was significantly more difficult than syllable production, onset consonant blending, and CVC blending.

For the phonological production variables, four of the independent variables measuring phonological production correlated significantly with phonological awareness subtests. Main FCC total processes (cluster reflections, and metaphons), Main FCC words correlated positively with three of the phonological awareness subtests: rhyme production ($r = .68$), initial consonant blending ($r = .51$), and CVC blending ($r = .47$). Conversely, the measure of total processes correlated negatively with three of the phonological awareness subtests: rhyme production ($r = -.62$), initial consonant blending ($r = -.52$), and CVC blending ($r = -.46$). Metaphons was the phonology measure that correlated significantly with the most phonological awareness subtests. It correlated negatively with rhyme production ($r = -.67$), alternating production ($r = -.57$), initial consonant blending ($r = -.49$), and CVC blending ($r = -.56$).

Phonological production scores correlated significantly with each other. A paired samples *t*-test indicated that of all the phonology scores only the SHAPE and Main FCC scores were significantly different between the two groups.

A summary of the key findings is presented below.

1. Total phonological awareness scores for children with phonological impairment and children with typically developing phonology were significantly different when subjects were matched by their classroom teacher.
2. Rhyme production was the only phonological awareness task on which children with phonological impairment and children with typically developing phonology performed significantly differently.
3. Syllable deletion and syllable segmentation did not correlate with each other or with any of the other phonological awareness tasks. In fact, the CVC blending task, a

skill in the phoneme level of manipulation, was found to be easier for the majority of the subjects than the syllable level task.

4. Two of the early/late production measures, *Percent-Corrupted-Correl* (PCC) and *misstatements*, were better predictors of performance on tasks of phonological awareness than any other phonological production measures.

CHAPTER 4 DISCUSSION

The purpose of this study was to investigate the relationship between phonological awareness and phonological awareness abilities in kindergarten children with and without phonological awareness. Measures used in this study were chosen because they represent a comprehensive assessment of both phonological awareness and phonological awareness skills. Previous studies have confounded the findings of previous studies on relationships between speech production and phonological awareness were controlled in this study. Independent variables that were controlled were age, controlled IQ, receptive language, expressive language, mother's level of education, and children. The results of this study are important because they can help speech language pathologists identify children at risk for phonological awareness and early reading difficulty. To determine whether phonological production is related to phonological awareness, three research questions were addressed: 1) Do children with and without phonological production deficits perform differently on tasks of phonological awareness? 2) Are there phonological error patterns that correspond with overall phonological awareness ability? 3) Are there phonological error patterns that correlate with specific phonological awareness tasks? 4) Do children in both groups show least difficulty with syllable level tasks and most difficulty with phoneme level tasks?

Phonological Awareness Task Differences by Group

Results from this study showed a significant difference in performance on the phonological awareness measures between the two groups when the independent variable of classroom teacher was used to match the two groups in a paired samples *t*-test. This finding is supported in the literature by several authors who found that children with speech impairments also had phonological awareness deficits (Juel, Rudeg, & Farnsworth, 1988; Lewis, Hughes, & Fletcher, 1991; Vowles, O'Brien, Gomburg, & Hopling, 2003; Windsor & Plante, 1992). However, other studies have not supported the finding that group differences exist (Bishop & Adams, 1998; Cain, 1993; Magnusson & Huseby, 1998, 1999). In previous research, expressive language ability was not usually controlled to single out a group of "purely" phonologically impaired children, so results were reported for children with phonological and language impairments. Furthermore, most previous studies did not control for educational environment, which was unique to this study. Larsen and Cain (1995) recruited subjects with and without speech impairment from the same schools, but the authors did not specify that they matched children by the same classroom teacher. In this study, when independent sample *t*-tests were used to determine whether group differences existed, no significant differences were detected. However, when subjects were matched by classroom, about differences were detected. This suggests that educational instruction is an important variable and lack of control can mask group differences.

The finding that children perform differently from situation to situation is not unexpected due to the volume of literature outlining that phonological awareness can be taught successfully in children with and without speech impairment (Adger & Beardslee, 1998;

(Russett et al., 1990). Phonological awareness training that produces long-lasting effects has been reported to be relatively low in intensity (28 minutes per week) and short in duration (12 weeks; Byrne & Fielding-Barker, 1991, 1993). Hence, it is likely that phonological awareness skills targeted directly in the kindergarten classroom could have had a marked effect on the children's phonological awareness scores. Results from a training study by Magnusson and Hauken (1994) confirm that reading instruction led to more advanced levels of phonological awareness by the end of first grade. No previous studies have controlled for educational environment (classroom teacher) in comparing children with and without speech (phonological) impairment on tasks of phonological awareness, as previous reports of instructional bias do not exist. This study clearly demonstrated that although differences in phonological awareness ability do exist between groups, instruction in the classroom could raise the ability level of children with and without phonological awareness deficits to reach any difference in abilities that would be attributed to the phonological deficits. Phonological awareness performance varies from child to child, and it is not possible to say that subjects in the NP group did better on every phonological awareness subtest than the FI subjects. Magnusson and Hauken (1994), Lervick and Catts (1995), and Lesh et al. (1997) reported no gender variability in phonological awareness, whereas in the FI group performed better on phonological awareness tasks than subjects in the NP group. However, it is important to note that at some schools both NP and FI subjects scored lower than FI subjects at other schools, and this phenomenon occurred in more than one low scoring school. Thus, we see the crucial effects of instruction on this finding.

There may be other factors associated with a school or classroom in which children are matched. For example, children attending the same school might have families of a similar socioeconomic or educational level. Level of mother's education was found to correlate significantly with early reading skills (Catts, Fey, Zhang, & Tomblin, 2002). However, in this study, mother's educational level was not found to correlate significantly to variance in the total phonological awareness score. This information again suggests that for intervention children with and without phonological impairment receive in kindergarten may have been a strong determinant in the children's phonological awareness skills level.

Of the phonological awareness subtests, the only one that was significantly different between the two groups was rhyme production. This finding suggests that rhyme production deficits may be associated with deficits of expressive phonology. Some very large differences were noted between the two groups on this task. Of the 10 children with phonological impairment, one subject was not able to produce any rhyming words and another child produced only one rhyme, whereas all of the children in the NP group were able to produce rhyming words. Six children in the NP group scored the maximum possible 10 points on rhyme production, but only four children in the PI group scored 10 points on the subtest. For nine of the six matched pairs, the NP subjects scored higher than the PI subjects on this task. For the remaining pair, the subjects scored were identical. For some other phonological awareness subtests, there were cases where the PI subject scored higher than NP subjects in a matched pair.

Rhyme production has been rarely measured in phonological awareness research. Deficits in rhyme production are associated with children with phonological impairment,

but not with children with normal phonology. Mays and Bontanos (1991) and Bontanos et al. (1997) measured both syllable production and rhyme production and found that performance on these two tasks differentiated groups of young children with and without phonological impairment. Similarly, Bird and Bishop (1992) measured rhyme production and found that there were significant differences in performance between children with and without phonological impairment.

However, results on whether rhyme production is also related to literacy acquisition are inconsistent. Bontanos et al. (1998) also measured rhyme production in children with and without phonological impairment and found that rhyme production did not differentiate groups of typical and delayed readers and spellers or children with phonological impairment, ages 3-5 and 6-8. Further investigation needs to be conducted to explore whether rhyming or phonological awareness ability specifically measured by production tasks can predict early literacy difficulties, or whether they can only provide descriptive value to differentiate groups of children with and without phonological impairment.

Phonological Production Relationship to Phonological Awareness

In examining the relationship between phonological awareness and phonological production, results from this study indicated that none of the independent variables that were used to measure phonology could individually account for the variance in the total phonological awareness score. However, the production variables of Nuclei PCC, Initiations, and Total Production were better predictors of total phonological awareness score than the SHAPE score. Nuclei-PCC, Initiations and Total Production were all

children from a multisyllabic word naming task, whereas the GRAPE score is based on presentation accuracy of poorly multisyllabic words.

The variable that accounted for the most variance in total phonological awareness was nonsense, which accounted for 12% of the variance ($r^2 = .458$). Previous studies have reported that certain phonological processes were associated with phonological awareness deficits. Ingleton and Fowler (1998, 1999) found that children who used nonsense and assimilation processes were more likely to have phonological awareness deficits than children who did not use these processes. Further, Catts (1993) found that weak syllable deletion and cluster reduction were associated with lower reading levels.

Lieber et al. (1997) reported that children whose errors were classified as "dread" under a framework proposed by Dodd (1995) had the lowest phonological awareness scores. They found that children with "consonant dread" error patterns (i.e., patterns that are not developmental, but are consistently used) performed poorest on phonological awareness subtests. Similarly in this study, nonsense correlated most significantly, though only moderately ($r^2 = .405$), with total phonological awareness scores and accounted for the greatest degree of variance of all the phonological awareness subtests. Nonsense accounted for more variance in total phonological awareness than the measure of total processes, which indicates that although some children with higher phonological awareness scores use other processes, nonsense differentiates children with both good and poor phonological awareness skills. Nonsense was also the phonological process that correlated with the greatest number of phonological awareness tasks. Findings from this study support previous findings that more advanced phonological error patterns can differentiate children with good and poor phonological awareness skills. In a typical

phonological analysis in which a speech sample was collected through every small picture description in comprehension, production or combined exposure would be an unusual phonological process that would not commonly occur in children with phonological impairment because few unanalysable words would be used (Dyson & Robinson, 1987). Dinnsen (1987) described articulation as an unusual or idiosyncratic process. Ingram (1986) called articulation an unusual process used by children with phonological disorders. Barbara Whangler labeled it as an idiosyncratic process that is "relatively uncommon" (2004, p. 60).

Differentiating between phonological impairment and articulation errors appears to be an important factor when attempting to identify children who are at risk for literacy deficits. Dodd, Russell, and Corkinnes (1991, reported in Dodd, 1995), found that children diagnosed with phonological disorder rather than articulation disorder or phonological delay performed more poorly on reading and spelling tasks than children in the articulation or delay groups. Dodd (1995) also reported that children with atypical phonological processes had more difficulty spelling unfamiliar words than children with other types of phonological error patterns.

Catts (1993), Lervick and Catts (1999), and Dodd (1993) have all used pronunciation errors reading from repetition of real and nonsense syllable/letter words as measures of expressive phonological ability. Justification for labeling this type of task as a phonological production task rather than a task of phonological memory comes from the fact that single word articulation tasks, such as the 40-item Articulation Proficiency Index in the *Children's Picture Test of Articulation*, do not contain words that consist entirely of the type of syllable onset as multisyllable words, such as transportation of sounds.

(insertions), and deletion of word syllables. Lewis and Freedman (1982) found that school-age children, adolescents and adults with a protracted history of speech and language difficulty performed more poorly than speakers with no history of speech and language difficulty on repetition tasks of multisyllabic real and nonsense words. Differences between groups in the multisyllabic repetition task existed in spite of the fact that speakers in both groups had normal phonology at the time that the multisyllabic task was administered. Further, a single-word retention test did not show differences between the groups. The multisyllabic repetition task seemed sensitive to measuring the previous history of speech and language impairment.

Multisyllabic production tasks have been most closely associated with reading skill rather than productive phonology skill. Stackhouse et al. (1988) found that a measure similar to the Mult PCC differentiated between typical and delayed readers and spellers. Lewis and Cole (1988) found that Mult PCC differentiated groups of good and poor readers before the phonological awareness measures and asserted that using phonologically complex words 'may be necessary to test or identification of less obvious but persistent phonological disorder' (p. 121).¹

In this study, the multisyllabic words cluster were primarily familiar words (refrigerator, doghouse, vegetable, animal, thermometer, microscope, hypodermic, and quipster). Two of the words, for refrigerator and aluminum, were not familiar to the majority of children tested. Children were observed to use the onsetal process of memorization for the most familiar word, quipster, as well as on less familiar words, such as microscope and aluminum. Mult PCC scores correlated highly ($r = .84$) with SHAPE scores, suggesting that both tasks were measuring a similar construct. Similarly, the total

process score and articulation score correlated highly with ERIAP score, indicating that the articulation word naming task measures some aspect of phonological production that is significantly related to single-word articulation.

In this study, measures of phonology were significantly different between the two groups, as expected. Multi-PCC scores and the Total Processes measure were significantly different between the two groups, indicating that both measures are effective in separating groups of children with normal and disordered phonology. Because Multi-PCC has been linked to reading outcomes (Catts, 1990; Larrison & Catts, 1994), and it was different between groups of children with normal and disordered phonology, it could be used as a simple screening test for identifying children with subtle or residual phonological impairment and to identify children at-risk for phonological awareness and literacy difficulty.

In examining relationships between specific tasks of phonological awareness and specific tasks of phonological production, the data show that the Multi PCC score correlated strongly ($r = .81, p < .01$) with rhyme production. Multi PCC also correlated significantly with initial consonant blending and CVC blending. That is, as morphological words were produced with more consonants correct, rhyme production and blending were also increased. Conversely total processes correlated negatively with rhyme production ($r = -.46, p < .01$), initial consonant blending ($r = -.31, p < .05$) and CVC blending ($r = -.48, p < .05$), indicating children showed that competency in using label phonology that they showed on tasks of phonological awareness.

From these correlations, it seems that rhyme production is the phonological awareness task that is most sensitive to phonological impairment. The other production

task, *deletion detection*, was also affected by phonological segment. This finding was supported by the findings reported by Bamford et al. (1996) and Green (1994), as noted in the results. Edwards & Kumpulainen (2000) also reported that phonological segment was significantly more difficult for children with phonological impairments.

Difficulty Level of Phonological Awareness Tasks

One goal of this study was to measure task difficulty among phonological awareness tasks. The literature suggests that syllable level tasks are easier, and phoneme level tasks are most difficult. Onset-rhyme level tasks are easier than phoneme level tasks. In this study order of difficulty of tasks was approximately the same for both groups of children, but the results do not directly reflect the order of task difficulty reported in the literature, as the syllable level tasks were not the easiest tasks for either group. Syllable deletion was easier than syllable representation for both groups, but the tasks were not significantly different for the two groups. Neither syllable level task correlated with total phonological awareness scores, with other phonological awareness tasks, or with each other. These findings did not support previous reports for prekindergarten and kindergarten age children. However, there is at least one other study that reported equivalent results for syllable and phoneme level tasks in school-age children. Bishop and Gadsden (1991) found that monolingual children found phoneme representation easier than syllable representation in first grade when compared with a group of bilingual children. They posited that phoneme level tasks were easier for English speaking children because English has many complex syllable onsets which place emphasis on phonemes in the onset. French, on the other hand, has more robust

4.3. syllable structure into two simplified words, so emphasis remains on the syllable rather than the phoneme.

Children in both groups performed best on the initial consonant blending task. This supports findings from several studies that suggest that children in kindergarten are able to manipulate onset-clone level tasks easier than phoneme level tasks. The next easiest task for children in both groups was the CVC blending task. This task required children to listen to three sounds presented orally, blend them together to form a word, then say the word. This task targets the phoneme level of phonological awareness. Children in both groups easily completed this task. The task did not require children to manipulate individual phonemes by deleting, moving, or reversing them. Phoneme blending tasks have not been reported to be easy to complete for children in kindergarten, but because children were at the end of their kindergarten, or in the case of two children, the first month of their first grade year, the children should have acquired some early level of phoneme awareness that the CVC blending task is able to capture.

Children in both groups found the final consonant segmentation task the most difficult. This finding supports previous claims that phoneme level tasks are more difficult than onset-clone or syllable level tasks. Koverly et al. (1983) previously found that initial consonant identification was easier than final consonant identification. This finding was replicated in this study. Most of the children in both groups were able to identify words that began with the same sound in the alternative-direction task, but few children in either group were able to identify words that ended with the same sound. This finding confirms that some phoneme level tasks tap skills at the highest levels of phonological awareness. However, performance on the CVC blending task brings into

quantities like word length demands and phoneme awareness. Yopp (1988) and Tunmer and Nesdale (1988) had previously cautioned against making comparisons of task difficulty when task demands were high. Tasks that require multiple operations have frequently been associated with the phoneme level of awareness. The phoneme deletion task used in this study requires relatively few mental operations compared with tasks that require segmentation and manipulation of phonemes. The high level of success on the CVC blending task for both groups is difficult to explain, even when considering task demands and general operations required to complete the task.

For the NP group, the middle set of tasks was ordered digram production (3%), syllable deletion and initial consonant deletion (3%), alternation detection (7%), syllable segmentation (8-9%), and digram detection (8-9%). This ordering does not conform to expectations prior to data collection. Many researchers have reported that syllable level tasks are easiest, or the last tasks that large syllable level awareness, syllable segmentation and syllable deletion, should be the easiest tasks. Subjects in this study were aged five and/or had recently completed their kindergarten year in the level of instruction focused on the onset-digraph and phoneme level. This may have influenced task performance for the syllable level tasks. Children were observed to try to clap the phonemes during syllable segmentation task. Also, some children could not keep track of syllables in longer words and seemed to clap-out more than one syllable for one-syllable words. No particular difficulties were observed during the syllable deletion task.

When Pearson correlation coefficients were calculated to determine the strength of the relationships between tasks, syllable level tasks did not correlate with each other or with the other phonological awareness tasks. All of the other phonological awareness

tasks correlated significantly and strongly ($r = .76$) with oral phonological awareness. From this finding, it is possible to conclude that the syllable-level tasks measure phonological awareness, and that this is the reason they do not correlate with other phonological awareness tasks or with each other. Bushara et al. (1999) proposed a similar conclusion when they found that among 3- to 4-year-old children with phonological impairment, those with better expressive language skills were better at word syllable segmentation than children with poor expressive language skills. The authors proposed that syllable-level tasks might tap into larger units of language analysis that correlate more strongly with syntax (for example, than with phonology).

Statistical analysis of task difficulty found that the two blending tasks were significantly easier than rhyme detection and final consonant segmentation. Research commonly reports that rhyming tasks are easy for young children. However, in this study, alternation tasks were easier than rhyme tasks for both groups, and blending tasks were phoneme-level blending, were easier than alternation.

The subtest that correlated with the most other subtests was initial consonant deletion. It correlated significantly with rhyme detection, rhyme production, alternation detection, alternation production, nasal consonant blending, CVC blending, and final consonant segmentation. MacKenzie et al. (1997) found that an initial consonant deletion task (phoneme deletion), along with alternation production and a final consonant supply task were more associated with reading and spelling than other tasks, such as rhyme production. The fact that initial consonant deletion correlates with many other subtests in this study confirms that the subtests are measuring a similar construct.

Although the expected hierarchy of syllable-onset-dysgraphia was not exactly followed by subjects in this study, onset-rhyme tasks were more like phoneme level tasks. Syllable level tasks did not correlate with either phonological awareness subtests or with total phonological awareness, which was an unexpected finding. One phoneme level task (final consonant categorization) was the most difficult task for all children in the study.

Clinical Applications

Because the blending tasks were easiest for all of the children in this study, blending could be used as a basis of approach to phoneme level tasks that involve letters and real words. Instead of focusing on onset-rhyme level tasks that involve alternative structures, an onset-rhyme blending task that provides children with an opportunity to manipulate letters representing onsets and word rhymes could be of great benefit. In schools where children are already at-risk for reading difficulty because, for example, socioeconomic status is low, phonological awareness instruction should begin early in the year, and it should be explicit, involving manipulation of letters and word parts. This study shows that children with phonological impairment have phonological awareness deficits when matched with children with normal phonological production in the same classroom. In classrooms where phonological awareness scores for both subjects were relatively high, differences in performance between children with phonological impairment and those without were reduced and may go undetected, although they do exist. Because some children with phonological impairment are placed in speech intervention programs before the beginning of kindergarten, it would be beneficial for these children to receive preventive phonological awareness training to try to reduce the

negative effects of the phonological environment on phonological awareness, even if they are performing within the normal range on some phonological awareness tasks. Similarly, children identified with attention or phonological impairment in kindergarten should be given additional, explicit instruction in phonological awareness that focuses on manipulating letters and parts of words in order to boost phonological awareness ability and prevent reading difficulties. Goodhouse (2000) reported on case studies of school-age children with phonological impairment. Rhyme production improved slowly during intervention, suggesting that it is a task that requires early and possibly long-term intervention.

Ford and Bailey (1992) argued that children's phonological awareness difficulties were not at the level of categorization of speech sounds but at the level of analysis of speech sounds. They said that failure to analyze words at the phoneme level was a primary deficit in children with phonological impairments. If this is true, children with resolved phonological production difficulty should be identified early and provided practice with phoneme analysis through explicit alphabet-based activities. To identify the children at greatest risk, a mother/teacher word naming task could be administered to children who have a history of early speech/phonological impairments but are no longer meeting speech and language screens. This might identify children whose expressive phonological difficulties have resolved but who remain at risk for reading impairment as opposed to typically named phonological awareness screens. Children who score lower on the Multi-PTC measure and are identified could be placed in preventive phonological instruction and early reading intervention to provide extra practice in phoneme manipulation.

Dodd (1985) stressed the importance of implementing phonological awareness training that comes *over* into reading, rather than training the ability to complete phonological awareness tasks without linking them to reading. Bradley and Bryant (1982) first identified the need to incorporate the alphabetic principle into phonological awareness tasks for improvement in reading ability to come. Children should be given information linking phonological awareness to reading as to many revolutions as possible to achieve this goal. Tasks can be designed to target auditory, visual, and cognitive levels of performance. For example, rhyme identification tasks can be presented orally or in writing, and the analogies relationships between word shapes (e.g., "a" endings in hat, bat), can be explicitly explained. Given the knowledge that production tasks appear to be more difficult than recognition tasks, children should be given many opportunities to produce rhymes (and to complete other phonological awareness tasks), in addition to the many opportunities they are given to perform recognition tasks.

Limitations and Weaknesses

The main limitation of this study is the small sample size. Even though the effect-size was large, a much bigger group of children should be tested, and they should come from many different kinds of schools and classrooms. This sample included only children with moderate phonological impairment, not those with severe or "severest" impairment. Children with severe phonological impairment who were recruited for the study were eliminated before measuring phonological awareness because the children also had expressive language deficits measured by the *Rece-Wexler Test of Early Grammatical Impairment Screening Test*.

Strengths of this study are that it controlled for many independent variables that were not controlled in previous studies. The role of instruction as measured by classroom has never been controlled in previous studies that investigated phonological awareness skills of children with and without speech impairments. This study showed how instruction can account for a large amount of variability in total phonological awareness skills, underscoring the importance of instruction. This study confirmed that the high PCC measure and analysis of phonological processes, especially deletions, are useful phonology measures that can help explain variation in total phonological awareness scores.

Future Research

The first extension of this research should be to increase the sample size in order to improve the findings of this study. It would also be of interest to investigate whether instruction is a critical factor in the development of phonological awareness, as suggested by this study. Studying complete kindergarten classes in different schools to look at cohort performance might reveal the role instruction is playing in phonological awareness development in children.

Because the goal of obtaining this information would be to identify children at risk for literacy difficulties, it would be necessary to look at reading and spelling measures for children at such a study at the end of first grade to see which specific phonological awareness skills are predictive reading and spelling outcomes. Also, it would be interesting to re-test the children on the multisyllable naming task to see if better PCC or a measure of total processes could predict literacy outcomes. If better PCC is a measure that could be used to predict literacy outcomes, then it would be beneficial to

know how children develop the ability to pronounce complex multi-syllable words. To understand the process better, children could be re-tested again at the end of first grade to see if there is evidence of solidifying phonological systems among all children or only among those who do not have difficulty sequencing reading and writing skills.

Rhyme production has been identified as a difficult skill among phonological awareness tasks. In spite of the many reports that kindergarten-aged children easily master rhyming tasks, Future studies might follow children who have difficulty with production based tasks of phonological awareness to see if they can predict literacy outcomes.

APPENDIX A RESEARCH APPROVAL

Institutional Review Board

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DATE: 22-Feb-2024

TO: Mr. Cynthia Orr
PO Box 117430
Gainesville

FROM: C. Michael Long, PhD, Chair *C. Michael Long*
University of Florida
Institutional Review Board (IRB)

SUBJECT: Approval of Protocol #2023-0-174

TITLE: Psychological Assessment in Kindergarten Children With and Without Speech Impairment

SPONSOR: Unfunded

I am pleased to advise you that the University of Florida Institutional Review Board has recommended approval of the protocol. Based on its review, the IRB determined that the research presents no more than minimal risk to participants. Given your protocol, it is essential that you obtain signed documentation of informed consent from the parent or legal guardian of each participant. When it is feasible, you should obtain signatures from both parents. Uncoated or the dated, IRB-approved informed consent is to be used when recruiting participants for the research.

If you wish to make any changes to this protocol, including the need to increase the number of participants recruited, you must discuss your plans before you implement them so that the Board can make their input on your protocol. In addition, you must report to the Board any unexpected complications that affect your participants.

If you have not completed this protocol by 22 Feb 2024, please telephone our office (352-392-4400) and we will discuss the renewal process with you. It is important that you keep your Department Chair informed about the status of this research protocol.

CM.L

APPENDIX B
PARENTAL CONSENT AND QUESTIONNAIRE

Department of Communication Sciences and Disorders
PO Box 117428
University of Florida
Gainesville, FL 32611

February 14, 2003

Dear Parent/Guardian,

I am a doctoral candidate in the Department of Communication Sciences and Disorders at the University of Florida, conducting research on language and reading skills of kindergarten children. My faculty supervisor is Dr. Linda Lundquist. The purpose of this study is to compare early reading skills (phonological awareness) of children with speech impairments and children without speech impairments. Results from this study may help teachers better understand what children are at higher risk for reading difficulty. These results may not directly help your child today, but may benefit future students. With your permission, I would like to ask you and your child to volunteer for this research.

Children will be given four standardized tests: a vocabulary test, a grammar test, a test of conversational abilities, and a test of articulation of speech sounds. They will also be given 13 early reading tests, such as rhyming and identifying words that begin or end the same. I will conduct all testing myself during regular school hours in a quiet room at the school. Testing will take place over four separate days (for approximately 30 minute sessions) during March, April and May. Your child will not be asked to meet any additional work to participate in the testing, and will have the opportunity to make up any work missed. The children do not have to participate if they do not want to, and they can stop the procedure at any time. Participation or non-participation will not affect the children's grades or placement in any program.

With your permission, your child will be videotaped during the sessions when speech sounds (phonological skills) are tested. The videotapes will be accessible only to me and to my supervising professor for verification purposes. I will maintain all the tapes and remove any information that identifies the child individually. At the end of the study, the tapes will be erased. We will replace names with code numbers on all documents and videotapes to keep your identity and your child's identity confidential to the extent permitted by law. Results will be reported only in the form of group data.

If you agree to let your child participate, with your consent, you will be asked to complete a brief questionnaire about your child's language history and language background. You do not have to answer any questions that you do not wish to answer. In addition, your child's teacher will be asked to complete a brief questionnaire about your child's language skills and general classroom performance. If your child currently receives speech services at the school, his/her speech-language pathologist will be asked to complete a questionnaire about the diagnosis, duration and type of treatment provided.

You and your child have through a voluntary consent for your child's participation in my time without compensation. There are no known risks or substantial benefits to the participants. No compensation is offered for participation. Group results of this study will be available in December 2002 upon request. If you have any questions about the research protocol, please contact me at 351-831-8048 or my faculty supervisor Dr. Lombardino at 351-883-0941. Questions or concerns about your child's rights may be directed to the UFIRB office: University of Florida, Box 1171160, Gainesville, FL 32611, (352) 392-0623.

Cynthia W. Coen
Dorinda Canolakis
University of Florida

—Please return the portion below—

I have read the procedure described above. I voluntarily give my consent for my child _____ to participate in Cynthia Coen's study of early reading skills. I have received a copy of this document.

Parent/Guardian _____

Date _____

Dr. Coen _____

Date _____

Parent Questionnaire

Child's Date of Birth _____

What language do you speak at home?

Are any other languages spoken at home? _____

At what age did your child begin attending a school program? _____

Does your child hear well? _____

Do you have any difficulty understanding your child? _____

Does your child have difficulty following directions? _____

Has your child ever received speech or language therapy or special tutoring at school? _____

Has your child been held back a grade? _____

Relationship to child: (circle one) Mother Father Stepmother Stepfather Guardian

Did you complete high school? _____ If not, highest grade completed _____

Did you attend college? _____ How many years? _____ Degrees earned? _____

Did you attend graduate school? _____ How many years? _____ Degrees earned? _____

Primary language spoken in the home _____

Other languages spoken in the home _____

Your first language _____

Check any behavior or problem that your child currently has

_____ Difficulty with speech

_____ Difficulty with hearing

_____ Difficulty with language

_____ Difficulty with vision (other than glasses or contact lenses)

_____ Difficulty with reading

_____ Difficulty with math

_____ Difficulty with spelling

_____ Difficulty with writing

Does your child get along well with his or her peers? _____

Does your child currently have or has your child had in the past any serious medical conditions? _____

If yes, please name the condition(s) _____

Teacher Questionnaire

Name of child _____ (School) _____

Age of child _____ Grade _____

Does the child interact appropriately with peers? _____

Does the child have difficulty following classroom instructions? _____

Has the child been retained or held back a grade? _____

Has the child been referred for any psychological testing? _____

Has the child had a hearing screening this school year? _____

Has the child received explicit instruction in phonological awareness? _____

Check any of the following you think pertain to the child:

____ Difficulty with speech

____ Difficulty with hearing

____ Difficulty with language

____ Difficulty with voice (other than common tones/tones/laughs)

____ Difficulty with reading

____ Difficulty with math

____ Difficulty with spelling

____ Difficulty with writing

____ Behavior problems

____ Social/emotional problems

Speech-Language Pathologist Questionnaire

Name of child _____ School _____

Age of child _____ Grade _____

1. What is the diagnosis for this child? _____

2. When was the child initially referred for services? _____

3. How long has the child received speech/language intervention? _____

4. What type of treatment has the child received?

Articulation only _____

Articulation and language _____

Phonological-based treatment _____

Cycle Approach _____

Metaphon Therapy _____

Other _____

5. Has this child received explicit phonological awareness training? _____
If yes, how long did such training last? _____

APPENDIX C
TEACHER CONSENT AND QUESTIONNAIRE

Department of Communication Sciences and Disorders
PO Box 417408
University of Florida
Gainesville, FL 32611

February 14, 2013

Dear Teacher,

I am a doctoral candidate in the Department of Communication Sciences and Disorders at the University of Florida, conducting research on language and reading skills of kindergarten children. My faculty supervisor is Dr. Linda Lundquist. The purpose of this study is to compare early reading skills of children with speech impairments and children without speech impairments. The results of the study may help teachers and language professionals better understand which children are at higher risk for reading difficulty. These results may not directly help you today, but may benefit future students. With your permission, I would like to ask you to volunteer for this research.

Once parental consent has been obtained, participating children will be asked to perform a series of tests measuring attention, vocabulary, grammar, and phonological awareness. Testing will be conducted by me on the school grounds. The entire testing procedure will take about two hours, and will take place over four 30-minute sessions in March, April and May. I will consult with you and other school officials to determine the best time to conduct testing. Your students will not be asked to miss any classroom work to participate in the testing. The children do not have to participate if they do not want to, and they can stop the procedure at any time. Participation or non-participation will not affect the children's grades or placement in any program.

After a parent gives consent to let their child participate, with your consent, you will be asked to complete a brief questionnaire about the child's classroom performance and general language skills. You do not have to answer any questions that you do not wish to answer. This information will be kept confidential, and no one else will be given any information provided by you as a part of this study.

All documents and notes about results from the testing will be maintained by me and my supervisor, and no other person will have access to the testing documents or individual results. The children's names, and parents', teachers', and speech language

pathologies. Names will be replaced with code numbers on all the documents to ensure confidentiality. Identity will be kept confidential to the extent permitted by law.

You have the right to withdraw consent for participation at any time, without consequence. There are no known risks or immediate benefits to participating. No compensation is offered for participation. Group results of this study will be available in December 2000 upon request. Questions or concerns about research participants' rights may be directed to the UH Mail Office, University of Hawaii, Box 112256, Kaneohe, HI 96711, (808) 292-8415. If you have any questions about this project, please contact me at (808) 821-8648, or my faculty supervisor, Dr. Lantieri, at (813) 292-3349.

Please sign and return this copy of this letter. By signing this letter, you give me permission to report your responses anonymously in the final manuscript to be submitted in part of my doctoral dissertation.

Thank you.

Cynthia Cox, M.A.
Doctoral Candidate
University of Hawaii

I have read the testing procedures above. I voluntarily agree to participate in Cynthia Cox's study of physiological responses and speech responses. I have received a copy of this description.

Teacher's Signature

Date

Teacher Questionnaire

Name of child _____ School _____

Age of child _____ Grade _____

Does the child interact appropriately with peers? _____

Does the child have difficulty following classroom instructions? _____

Has the child been retained or held back a grade? _____

Has the child been referred for any psychoeducational testing? _____

Has the child had a hearing screening this school year? _____

Has the child received explicit instruction in phonological awareness? _____

Check any of the following you think pertain to the child

____ Difficulty with speech

____ Difficulty with hearing

____ Difficulty with language

____ Difficulty with rhymes (other than corrective insertions/plans)

____ Difficulty with reading

____ Difficulty with math

____ Difficulty with spelling

____ Difficulty with writing

____ Behavioral problems

____ Social/emotional problems

APPENDIX D
UNIVERSITY LANGUAGE PATHOLOGY/ CONSENT FORM AND QUESTIONNAIRE

Department of Communication Sciences and Disorders
PO Box 117430
University of Florida
Gainesville, Florida 32611

February 12, 2003

Dear Speech-Language Pathologist,

I am a doctoral candidate in the Department of Communication Sciences and Disorders at the University of Florida, conducting research on the phonological awareness of kindergarten children with and without speech impairment. I am writing under the supervision of my doctoral advisor, Dr. Linda Lombardino. The purpose of this study is to determine whether children with speech impairment perform differently from children without speech impairment on tests of phonological awareness. This research is the basis of my doctoral dissertation.

If you agree to participate in my study, you will be asked to help me identify kindergarten children with speech impairment who may participate in the study. Children who have expressive phonological or articulation disorders or delays without concurrent language impairment are needed for this study. A total of 20 children with speech impairment are needed.

Once the children are identified, I will ask the classroom teacher to send home a parental consent form with each child. If the parent agrees to let their child participate in the study, I will ask the child's teacher to fill out a short questionnaire about the child's classroom performance and general language abilities. This will be followed by fill out a questionnaire about the diagnosis, and nature and duration of impairment.

Participating children will be asked to complete a series of tests, including vocabulary, grammar, articulation, non-verbal ability, and phonological awareness. The test will take about five hours per child, and will take place in 30-minute sessions over four days.

Research is being conducted under the guidelines of the Institutional Review Board of the University of Florida. All testing documents will be kept confidential. If you have any questions about this project, please contact me at (354) 395-9548 or my faculty supervisor, Dr. Linda Lombardino, at (352) 393-2613.

Thank you

Cynthia W. Cox, Ed. A.

Electoral Candidate

Department of Constitutional Services and Oversight

University of Florida

Speech-Language Pathologist Questionnaire

Name of child _____ School _____

Age of child _____ Grade _____

1. What is the diagnosis for this child? _____

2. When was the child initially referred for services? _____

3. How long has the child received speech/language intervention? _____

4. What type of treatment has the child received?

Articulation only _____

Articulation and language _____

Phonological-based treatment _____

Cycle Approach _____

Intonation Therapy _____

Other _____

5. Has the child received explicit phonological awareness training? _____
 If yes, how long did such training last? _____

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.


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